The Federal Plan for Meteorological Services and Supporting Research

FISCAL YEAR 1982

FEDERAL COORDINATOR FOR METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

FCM P1-1981

U.S. DEPARTMENT OF COMMERCE/National Oceanic and Atmospheric Administration

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The Federal Plan for Meteorological Services And Supporting Research

FISCAL YEAR 1982

MARCH 1981
WASHINGTON, D.C.

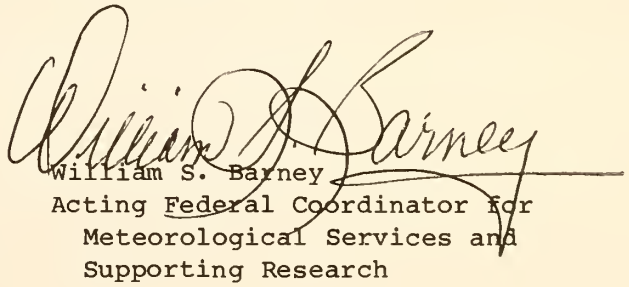
PREFACE

This is the seventeenth Federal Plan in an annual series developed by the Federal Coordinator for Meteorological Services and Supporting Research in response to Section 304 of Public Law 87-843. The Plan describes the Nation's meteorological programs designed to reduce the economic and social impact of natural disasters, promote the Nation's welfare and economy, preserve and enhance the environ, ment, and strengthen the national security.

Section 1 indicates the role that weather information plays in business, aviation, agricultural, governmental, and public activities. Section 2 of this Plan highlights many aspects of interagency cooperation that is so essential to meet the needs for meteorological services now and for the challenges of the future. Section 3 contains a discussion of resource information and analysis based on President Reagan's FY 1982 budget request of March 10, 1981.

The final section describes the National Climate Program as a separate issue. The appendices contain a compilation of independent interagency coordination and statements on weather activities submitted to the Office of the Federal Coordinator.

The preparation of the Federal Plan is performed by the Interdepartmental Committee shown on the inside front cover. This committee and its subcommittees conduct systematic, continuous reviews of basic and specialized meteorological requirements, services, and supporting research according to the guidelines set forth in the Office of Management and Budget Circular A-62.



William S. Barney
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Supporting Research

THE FEDERAL PLAN FOR METEOROLOGICAL SERVICES
AND SUPPORTING RESEARCH
FY 1982

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SECTION 1

INTRODUCTION

Weather, the product of changes constantly occurring in the atmosphere, affects all life on earth. The beginnings of human civilization and the course of history have been influenced by weather and climate. Weather is still one of the imponderables of warfare.

Realizing the dependence on weather--for rain to water crops, for wind to carry us across the sea, and for military operations--scientists have sought to explain and predict the behavior of the atmosphere in which we live.

Centuries of study have laid the foundation for the modern science of meteorology, devoted to measuring, describing, understanding, and predicting changes in the earth's atmosphere, a fluid so vast there are two million tons of it for each person on earth.

Twentieth century technology has given meteorologists powerful new tools to increase our understanding of the atmosphere. Today, weather satellites, rockets, aircraft, and radar explore and measure conditions far above the ground; unattended platforms automatically observe surface weather on land and at sea; advanced computers quickly organize the millions of pieces of data gathered by various instruments into a form that can be used in providing weather services.

While modern equipment for measuring and forecasting the weather has enabled the meteorologist to improve weather services, civilization has become increasingly vulnerable to changing weather. Weather is more critical in the complex activities of daily life. The extremes of weather pose greater hazards than ever before. As population and industry grow, the mounting damages caused by hurricanes, tornadoes, severe thunderstorms, floods, hail, and heavy snow have an ever-increasing effect on the economy. To prevent loss of life and destruction of property, improved forecasts and better means of dissemination are required.

The National Research Council Select Committee on the National Weather Service developed the following table showing the cost in FY 1980 for acquisition and dissemination of weather data. The table shows the annual costs of daily weather information provided by the civilian agencies of Government and what the private sector expends on its dissemination to the public.

Table 1.1
ANNUAL COSTS OF DAILY WEATHER INFORMATION

	All Civilian Agencies	Non-Govt.
Acquiring weather data, per capita	$2.29	
Disseminating weather data, per capita		$ 7.55
Acquiring weather data, per taxpayer	$3.65	
Disseminating weather data, per taxpayer		$12.06
Acquiring weather data, per household	$6.40	
Disseminating weather data, per household		$21.12

The data given are based on estimates (per taxpayer and per household) from the Census Bureau. The dissemination costs are a minimum estimate. Next to the mail service, weather information is the most widely used service provided by the Government. At one cent per taxpayer per day this service is highly cost effective.

It is interesting to note that the private sector spends more than three times as much for dissemination of data and products than the civil agencies spend on acquisition and processing.

The technological explosion is creating many new problems for the meteorologist to solve. Developments in aeronautics, agriculture, business, commerce, engineering, transportation, and sophisticated weaponry bring added demands for knowledge of weather and climate.

Weather information has always been essential to the aviation industry. Because the safety and efficiency of every flight depend on weather, special observations and forecasts are made for the benefit of aviation, and the information is disseminated to pilots by means of personal briefings, radio broadcasts, communication networks, and telephone answering devices. Aircraft are flying higher and faster, and fuel is becoming more and more expensive, creating a need for weather information and forecasts to higher altitudes as well as for accurate predictions of weather in the distant areas where the aircraft will land. General aviation requirements for weather service are increasing at an exponential rate because of changes in aircraft types, more flights being conducted under instrument flight rules, and the constant increase in the number of commuter flights.

Changing technology has affected agriculture, too. Agriculture is made up of many interactive biological systems, all greatly influenced by weather.

Forecasts of weather conditions that affect farm operations are among the oldest services provided by the Federal Government. Weather variations influence seed germination, development of insects, disease and weeds, the development of the crops and livestock, the efficacy of chemical control measures and their environmental impact, and the amounts of energy required. Combining weather information and agricultural technology in planning and decision-making is one of the expanding frontiers in improving the production efficiency of American agriculture.

Knowledge of climate has a host of new uses in the modern world. Manufacturers and distributors rely on climatological data in advertising, stocking, and servicing their merchandise. Locations for nuclear reactors and the orientation of airport runways are determined by studying the prevailing wind direction and other aspects of an area's climate. The National Climate Program was established in 1978 by Public Law 95-367 as a means to assist the country and the world to understand and respond to natural and man-induced climate processes and their implications. The program, one of research and applications, requires coordinated efforts among the major agencies that develop climate understanding and knowledge, that use climate information in accomplishing their particular mission, and that are responsible for the active dissemination of climate information to promote its utility to Government, industry, and the public.

Today, every business in the United States is affected directly or indirectly by weather. Weather influences the markets for products of commerce and industry; the safety and efficiency of land, sea, and air transportation; the yield of crops; and the success of a business trip, a vacation, or a military operation. The health, comfort, and prosperity of the entire Nation depend in large part on the weather.

Although weather has always been a controlling factor in man's activities, there has never before been a time when the needs and uses of weather information were so many and varied as they are today. These growing needs for weather information are reflected in the programs of many Government agencies. At the present time, the Departments of Commerce, Agriculture, Defense, Energy and Transportation, and the Environmental Protection Agency, the National Aeronautics and Space Administration, and the National Science Foundation fund weather activities.

Government agencies have a vital stake in weather activities for several reasons. They may be legally responsible for providing weather service, as the Department of Commerce is, they may require weather services to carry out their own missions (e.g., the Federal Aviation Administration uses weather information in safely operating its air traffic control system; the military departments need weather services in all of their operations; and the Department of Energy, the Environmental Protection Agency, the National Science Foundation, and the National Aeronautics and Space Administration require weather support for research projects), or they may be legally responsible for developing unique technology which contributes to the improvement of weather services. The NASA effort in the meteorological satellite area is an example.

SECTION 2

FEDERAL COORDINATION AND PLANNING

COOPERATION IN METEOROLOGY

Cooperation in meteorology has been practiced since the early days of the science. As soon as it was recognized that weather forecasts require substantial amounts of observed weather data, it became apparent that this cooperation, like the weather itself, transcended national boundaries.

Formal cooperative efforts were fostered initially by the International Meteorological Organization, founded in 1878. These international programs are now coordinated and planned under the World Meteorological Organization (WMO). This latter organization, a specialized agency of the United Nations, facilitates worldwide cooperation in weather observations, meteorological centers to provide services to international commerce, communications systems for the exchange of weather data, standardization of observations and statistics, applications of meteorology to human activities, and research and training.

As a member of the WMO, the United States participates fully in this sharing of data internationally. On the national scale, an analogous effort exists. The original responsibility for making weather observations and forecasts in 1870 was assigned to the Secretary of War. Through the years, meteorological functions expanded to include other Federal agencies with weather-dependent missions to fulfill.

To determine the extent of interagency cooperation that exists outside the Federal Coordinator structure, the Office of the Federal Coordinator for Meteorology (OFCM) conducted a survey which is summarized in Appendix A.

PLANNING AND COORDINATION OF MULTIAGENCY TECHNICAL PROGRAMS

Role and Planned Activities of the Office of the Federal Coordinator for Meteorology

Since World War II, science and technology have played an ever-increasing role within Federal agencies. The principal evidence of this remarkable increase in scope has been in R&D expenditures. As the expenditures have grown, the number of agencies assuming important roles in science and technology have multiplied. Because many agencies have common interests in science and technology, there has been a natural evolution in which many agencies seek solutions to their problems within the same scientific disciplines and technologies. This situation has produced a need for mechanisms to exchange information between agencies, to coordinate activities, and (in some cases) to manage programs in which several agencies participate (i.e., the Next Generation Weather Radar (NEXRAD) program described elsewhere in this plan). These mechanisms have been brought into being as a result of the interest of Congress and the Office of Management and Budget (OMB) in obtaining an overall view of a Federal program involving many agencies to insure that agency programs are complementary.

"Coordination" can mean many things. To some, coordination has taken place when each is informed of what the other is doing. To others, coordination should be more rigid and extensive. About all one can say is that coordination should be sufficient to achieve the objectives set for the coordinating mechanism. Coordination acceptable for basic research may be totally inadequate for development or operations.

In any Federal scientific program requiring multiagency coordination and planning, definition of long-range goals and development of Federal plans and programs for meeting these goals are usually required. There is also the need for a single Federal budget showing funding requirements for research, operations, and facilities by agency and by function. Procedures must be initiated for reviewing agency programs essential to the achievement of Federal plans, particularly where other agencies are dependent on these programs and where failure to carry them out will jeopardize the entire plan. There are also many constraints. For example, actions should not adversely affect an agency mission and must not be inconsistent with agency statutory responsibilities.

Mechanisms aimed at effective interagency planning and coordination have existed for many years. From 1921 until 1933, there was even a Federal Coordinating Service to coordinate Federal specifications, contracting procedures, Government freight and traffic, and disposition of surplus property. Today, in our more complex society, the need for interagency planning and coordination is far greater and has taken many forms. In research and development, the Federal Coordinating Council for Science, Engineering and Technology and its subordinate committees (e.g., Atmosphere and the Oceans; Health and Medicine; Food and Renewable Resources; International Science, Engineering and Technology; Ocean Pollution Research, Development and Monitoring; Intellectual Property and Information) are the most extensive. Interagency planning and coordination responsibilities are also vested in departments and agencies having the major responsibility in the area in question. Furthermore, ad hoc groups are created to meet temporary needs for interagency planning and coordination.

On November 13, 1963, the Office of Management and Budget (then the Bureau of the Budget) issued Circular A-62 setting forth guidelines and procedures for planning and conducting Federal meteorological services, and applied research and development to improve such services. The Circular reaffirmed the central role of the Department of Commerce with respect to basic meteorological services; clarified respective responsibilities of the Department of Commerce and the user agencies for basic and specialized meteorological services; established procedures for facilitating coordination and the timely resolution of outstanding issues; provided for evaluating user requirements within the context of a balanced and integrated Federal plan; and fixed responsibilities for a continuing and systematic review of meteorological services and supporting research.

The Circular specifically excluded basic research in meteorology. It also did not apply to (1) "the division of responsibility between the Department of Commerce and the National Aeronautics and Space Administration for development of meteorological satellites; and (2) meteorological activities involving special military security considerations."

Circular A-62 called on the Department of Commerce to "prepare and keep current a plan and obtain periodic information on its implementation, for the efficient utilization of meteorological services and supporting research." The plan, relating proposed programs to fiscal year and longer-range objectives, was to be available for the annual review of the various agencies' budgets.

Finally, the circular required the Department of Commerce to "establish procedures designed to facilitate a systematic and continuing review of basic and specialized meteorological requirements, services, and closely-related supporting research." The Department was to obtain the advice and assistance of the principal agencies providing or utilizing meteorological services and was to establish appropriate arrangements for obtaining continuing advice from the principal agencies concerned.

On January 23, 1964, the Department of Commerce issued an implementation plan which provided for a Federal Coordinator for Meteorological Services and Supporting Research to carry out its responsibilities under the Circular. The plan also outlined a committee structure consisting of the Federal Committee for Meteorological Services and Supporting Research and Interdepartmental Committees for Meteorological Services (ICMS) and Applied Meteorological Research (ICAMR).

The Assistant Secretary of Commerce for Science and Technology was named Chairman of the Federal Committee. The Chief of the U.S. Weather Bureau was named Federal Coordinator and was assisted by a full-time Deputy Federal Coordinator. The Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) was physically and organizationally removed from the U.S. Weather Bureau and was assigned directly to the Assistant Secretary of Commerce for Science and Technology.

The Federal Committee for Meteorological Services and Supporting Research provided high-level policy guidance for the Federal Coordinator, reviewed and validated proposed Federal meteorological plans, and resolved differences which arose in connection with the preparation, monitoring, and coordination of Federal meteorological activities. All agencies having need for meteorological services either for their internal operations or a part of the direct service to a clientele group were represented on the Federal Committee.

Interdepartmental committees were to do the principal work of coordination of meteorological activities, the systematic and continuing review of basic and specialized meteorological requirements, services and supporting research, and the preparation and maintenance of the Federal meteorological plan. Membership on the ICMS consisted of the commanders of the military weather services, Director of the National Weather Service, and representatives of equivalent status in user departments and agencies. Membership on the ICAMR consisted of senior managers and directors of department and agency programs of applied meteorological research. The ICMS established subcommittees along service lines (basic and specialized), while the ICAMR established subcommittees along functional lines (observation, data processing, etc.).

Issues that could not be resolved at the Federal Committee level were to be referred to the heads of agencies concerned. If an issue still could not be resolved in this manner, it would then be referred to the Executive Office of the President for resolution.

The OFCM was established and staffed in the first half of 1964. By the end of 1964, the full-time staff consisted of ten professionals and five sub-professionals, and four senior personnel on detail from other agencies.

The preceding discussion describes the manner in which the Department of Commerce chose to implement Circular A-62 in 1964. It is useful to review briefly how the Office of the Federal Coordinator for Meteorological Services and Supporting Research evolved from that time forward.

The Environmental Science Services Administration (ESSA) was established on July 13, 1965. At this point, the Chief of the U.S. Weather Bureau became Administrator of ESSA and his interests and responsibilities were expanded to include the activities of the United States Coast and Geodetic Survey. Attention to the OFCM and emphasis on its activities began to diminish as ESSA took on broader responsibilities.

The Interdepartmental Committees each averaged a little more than seven meetings a year through 1967. On August 8, 1967, a significant change was made in the military membership on the Interdepartmental Committee for Meteorological Services with the establishment of the Office of the Special Assistant for Environmental Services in the Office of the Joint Chiefs of Staff, Department of Defense. At that time, a General officer was named to head that office and to represent the military weather services on the Committee. The original agency membership on the Interdepartmental Committee for Applied Meteorological Reseach held up well with the exception of one or two agencies that had named members who were organizationally too far above the program level being coordinated.

Perhaps the most significant change in the Federal Committee structure occurred in October 1970, when the ESSA Administrator was the same individual who, as Chief of the U.S. Weather Bureau, had a great deal to do with the establishment of the OFCM, now became Administrator of a much larger organization, the National Oceanic and Atmospheric Administration (NOAA), which included the National Marine Fisheries Service and Sea Grant, in addition to the former ESSA organizations. More importantly, increasing activity in the marine area placed heavy demands on the Administrator's and the organization's time.

At this same time, NOAA became an agency within Commerce and no longer reported to the Assistant Secretary for Science and Technology. As a result, the Administrator of NOAA, for a short time, served both as Federal Coordinator and Chairman of the Federal Committee. He relinquished his duties as Federal Coordinator in 1972. The functions first resided in the Associate Administrator for Environmental Monitoring and Prediction, NOAA, and then in the Assistant Administrator for Oceanic and Atmospheric Services. For a very brief period, the Director, National Weather Service, served as Federal Coordinator. See Figure 2.1 for the history of the staffing of the positions of Chairman, Federal Committee, Federal Coordinator, and Deputy Federal Coordinator.

The Federal Committee in its first meeting in 1978 agreed to review the Federal coordinating mechanism and to recommend ways the system might be improved and made more efficient. During its first meeting in 1979, the Deputy Federal Coordinator summarized the history of the Office of the Federal Coordinator and pointed up some of the problems inherent in the Circular A-62 guidelines. The Deputy Federal Coordinator also advised the committee on the preliminary findings of a GAO study (subsequently issued as LCD-80-10,

October 16, 1979, and entitled "The Federal Weather Program Must Have Stronger Central Direction").

At the direction of the Federal Committee, the Deputy Federal Coordinator presented, during the second meeting in 1979, plans for the realignment of the OFCM. The OFCM was expanded with a permanent staff headed by a full-time Deputy Federal Coordinator. The expanded staff included the Deputy Federal Coordinator, five NOAA professionals plus three support staff, two DOD officers (one Air Force Colonel and one Navy Captain), and one FAA professional for a total of nine full-time professional and three support personnel. The NOAA Assistant Administrator for Oceanic and Atmospheric Services continues to serve as Federal Coordinator. The former Interdepartmental Committee for Meteorological Services and Interdepartmental Committee for Applied Meteorological Research were combined into a single committee, the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR). The Deputy Federal Coordinator chairs the combined committee. See Figure 2.2 for the current committee structure.

Future Needs and Directions of Federal Weather Programs

The Office of Management and Budget, in its FY 1980 guidance to the Department of Commerce, also evidenced concern over the absence of Government-wide crosscut studies and plans addressing the future needs and directions of Federal weather programs and activities. Results of this guidance included crosscut analyses of agency FY 1981 programs for new weather radars and for automating surface weather observations. These expensive programs will have a great impact on the weather services over the next 20 to 25 years. In addition, a program of special studies and analyses by the OFCM was initiated. The first two studies, one dealing with the issue of future directions of the three large Federally-operated numerical weather processing centers, and the second dealing with the roles, missions, responsibilities, and long-term plans of agencies, were initiated. Reports on these studies are being forwarded to OMB through the Federal Coordinator.

The study of the numerical processing centers also was in response to the strong concerns expressed by the GAO in its previously referenced report. The roles and missions study was intended as a first step in a logical process leading to a long-range Federal Plan as called for by Circular A-62 and FY 1980 OMB guidance.

The FY 1981 OMB guidance to the Department of Commerce once again addressed the planning issue and requested that Commerce undertake with the concerned agencies analyses of major coordination and program issues and provide an activity plan by 1 July 1980, which identified priority issues to be reviewed. The plan was submitted by the date requested with tentative approval by the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR). The date for submission prohibited full coordination with the agencies. Because the activity plan was to culminate in a long-range Federal Plan, the ICMSSR directed that the activity plan be revised and expanded. The Chairman of the Federal Committee for Meteorological Services and Supporting Research (FCMSSR) directed that studies recommended in any activity plan involving fundamental Government policy be conducted in-house. Work on the revised activity plan and the long-range Federal Plan is underway with agency participation.

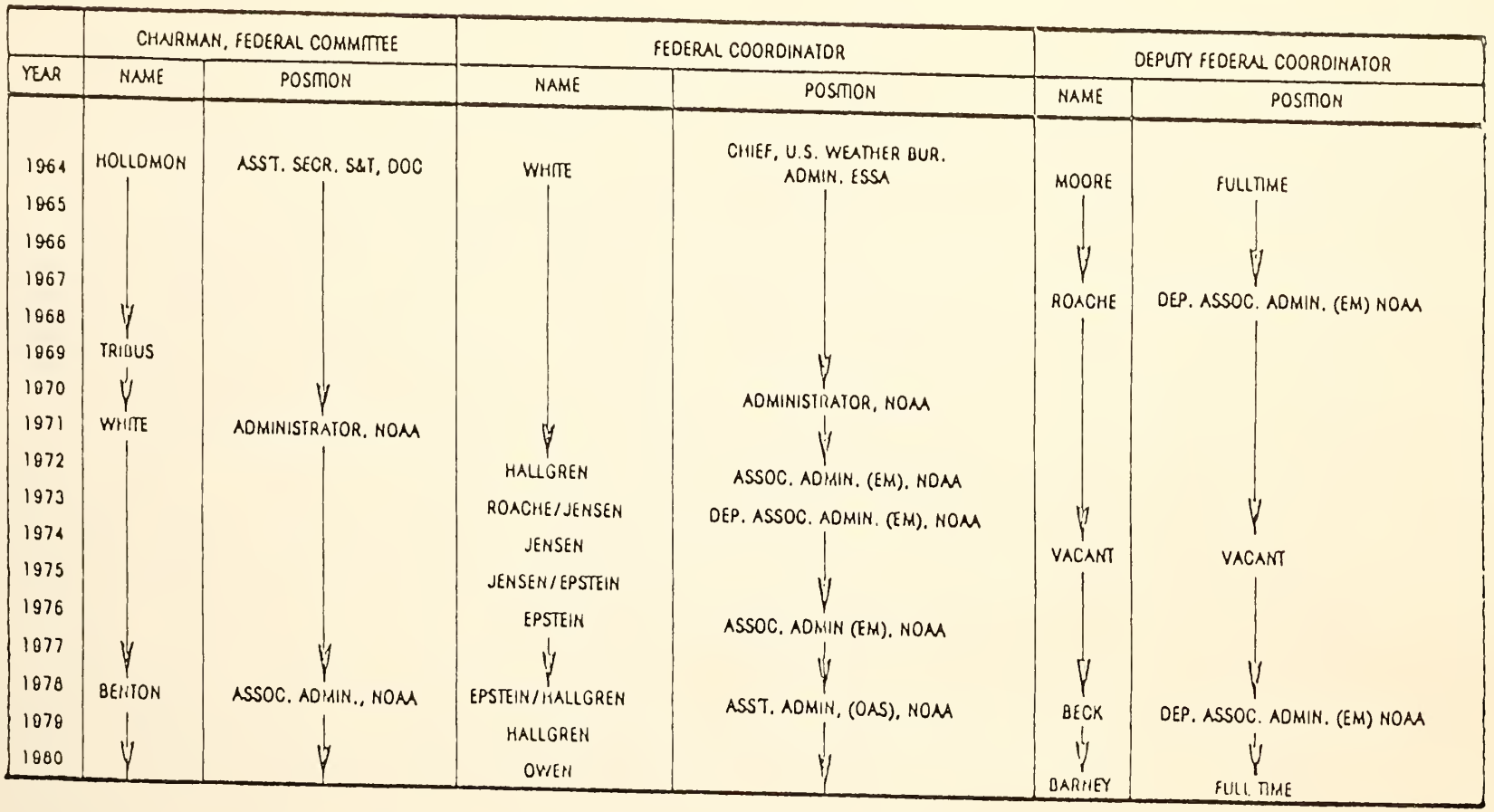


Figure 2.1
History of Staffing of the Positions of Chairman, Federal Committee and Federal and Deputy Federal Coordinator

FEDERAL COMMITTEE FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH (FCMSSR)

FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

INTERDEPARTMENTAL COMMITTEE FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH (ICMSSR)

SUBCOMMITTEES

AVIATION SERVICES

SPACE ENVIRONMENT FORECASTING

SYSTEMS DEVELOPMENT

Working Groups

- o Automated Surface Observations
- o Automated Weather Information Systems
- o Radiological, Gaseous and Particulate Transport Models
- o Weather Radar Systems

OPERATIONAL ENVIRONMENTAL SATELLITES

BASIC SERVICES

Working Groups

- o Agricultural Meteorological Services
- o Cooperative Backup Among Operational Processing Centers
- o Dissemination of NMC Products
- o Hurricane Operations
- o Marine Environmental Predictions
- o Meteorological Codes
- o Metric Implementation
- o Operational Processing Centers
- o Severe Local Storms Operations
- o Surface Observations
- o Upper Air Observations
- o Weather Radar Observations
- o Winter Storms Operations
- o World Weather Program

Figure 2.2
FEDERAL COMMITTEE STRUCTURE

FEDERAL PLANS AND COORDINATION ACHIEVED

Federal Plans

The preparation of Federal Plans is a major responsibility of the Federal Coordinator and requires extensive planning and coordination. Generally, Federal Plans are prepared for each of the specialized meteorological services and for meteorological programs common to two or more agencies. In most cases, the preparation of Federal Plans is facilitated by the existence of individual Agency plans for the service or program involved. The Federal Coordinator compiles input from the involved agencies and proposes a unified plan for consideration.

The Office of the Federal Coordinator published the following plans during FY 1980:

- Federal Plan for Meteorological Services and Supporting Research
- World Weather Program Plan (published biannually)
- National Hurricane Operations Plan
- National Winter Storms Operations Plan
- National Severe Local Storms Operations Plan

The Federal Plan for Meteorological Services and Supporting Research, as indicated in the Preface, is required by Section 304 of Public Law 87-843. In connection with the budget presentation for each fiscal year, the Congress is provided with a horizontal budget showing the totality of the programs for meteorology.

The World Weather Program Plan is required, pursuant to Senate Concurrent Resolution 67 of the 90th Congress, to present to the President a consolidated estimate of the United States participation in international meteorological programs.

The National Hurricane Operations Plan, updated on an annual basis, presents procedures agreed upon by the U.S. Departments of Commerce, Defense, Transportation, and the Federal Emergency Management Agency, for providing warning services on Atlantic and Pacific hurricanes. The service is an interdepartmental joint effort to provide the Nation and designated international recipients with environmental data, forecasts, and assessments concerning tropical and subtropical weather systems.

The National Severe Local Storms Operations Plan, updated annually, describes the responsibilities, roles, and procedures followed by the U.S. Departments of Commerce and Defense, the Federal Emergency Management Agency, and the Federal Aviation Administration, in observing, forecasting, and communicating information on severe local storms over the United States.

The National Winter Storms Operations Plan identifies agency responsibilities in acquiring weather information for use in predicting and providing adequate and timely warnings of severe and crippling winter storms along the

east and Gulf coasts of the United States. Agencies involved are the U.S. Departments of Commerce, Defense, and Transportation. The Plan covers the period November 1 to April 15 each year, since a relatively high incidence of winter storms is expected in that period, and it is updated on an annual basis.

Coordination Achieved

Recent events have stimulated renewed Federal interest in the coordination and strengthening of the overall Federal weather program which is carried out within many Federal agencies. In the review of the natural resources programs of the Federal Government, the President's Reorganization Project noted that some efficiencies and savings might result from the consolidation or integration of some weather programs. The General Accounting Office (GAO) report LCD-80-10, "The Federal Weather Program Must have Stronger Central Direction," October 1979, urged more centralized planning and direction for Federal weather service activities. The Office of Management and Budget (OMB) undertook crosscutting budget reviews for selected weather programs in the FY 1981 budget in order to assure coordinated effort among the agencies involved.

As a result of this increased interest, increased staff and other resources were provided to the Office of the Federal Coordinator. These increases in general were provided by the Federal agencies with major weather programs such as the Departments of Commerce, Transportation, and Defense. In addition to providing an ongoing focus for the coordination of interagency weather programs, the increased capability in the Office of the Federal Coordinator will be used to conduct studies and assessments that are responsive both to the needs of the Executive Branch and to the guidance from the Congress.

The crosscut analyses of the operational capabilities of the three meteorological centers and the roles, missions and programs of the Federal agencies, which were completed in June 1980, will enhance comprehensive interagency coordination. The following are some specific areas where interagency cooperation has been very effective during FY 1980-1981.

Next Generation Weather Radar (NEXRAD)

Background

The Department of Commerce (DOC), Department of Defense (DOD), and Department of Transportation (DOT) all require information concerning the location, intensity, and movement of hazardous weather activity to meet their mission responsibilities. This is currently being done using aging weather radars and air traffic control radars. The present weather radars lack the capability to detect wind-related weather phenomena and have increasingly severe maintenance problems. The air traffic control radars also lack wind-related detection capability and, because they are not optimized for weather detection, have limited reflectivity (precipitation) related capability as well. Since the existing radar systems have become antiquated and do not meet weather-related mission needs for the three departments, a common need for a radar system with improved capabilities for detecting hazardous weather conditions has been stated by the three departments.

To meet the requirements of the three agencies, an interagency Working Group on Next Generation Weather Radar (WG/NGWR) was established within the

Federal coordinating structure. This working group was the focus for interagency weather radar development and planning activities, including the preparation of a NEXRAD concept. The concept paper outlined the approach for the development, procurement, and operation of a joint (DOC, DOD, and DOT) national weather radar network. Specifically, it recommended prompt action to establish a joint program management activity, define agency responsibilities, establish detailed program plans, and initiate requirements definition and specification preparation.

The Federal Committee for Meteorological Services and Supporting Research approved the concept paper and endorsed the establishment of a Joint System Program Office (JSPO) to be the central focus for NEXRAD. The JSPO was to be staffed by members from the participating departments and supported financially by each.

Before proceeding with the NEXRAD program at an accelerated pace, the Office of Management and Budget (OMB) directed the Federal Coordinator to conduct a crosscut analysis. During October 1979, the analysis was accomplished, and it concluded that there is a valid basis for replacing the aging weather radars currently in use. The study agreed that the NEXRAD system with Doppler capability would make dramatic improvements in warnings and provide new information of major significance to aircraft safety. However, the study stated that consideration should be given to a mix of Doppler and non-Doppler radars, with the decision between a mixed and a full Doppler system based on careful study. The crosscut analysis further concluded that the fundamental technology to support NEXRAD has been developed, but that a substantial amount of work remains to transfer Doppler radar technology to operational use in the field. It also supported the establishment of a Joint System Program Office and the approval of the NEXRAD concept paper, including the FY 1981 budget requests of the departments for NEXRAD development. In January 1980, the OMB approved the analysis and authorized the participating agencies to proceed with the program through the system validation phase.

The JSPO was formed to move ahead on plans and specifications for NEXRAD. The JSPO was initially staffed by two persons from DOC to start planning for the acquisition and development of NEXRAD. By the end of the fiscal year, 14 persons were assigned to the JSPO, which included 10 from DOC, two from DOD, and two from DOT. The DOC is the executive department, and NOAA the implementing agency.

In December 1979, a decision was made to follow OMB Circular A-109, Major System Acquisition, for the acquisition and development of NEXRAD. The circular requires four important key decisions to be made and certain activities to be completed before each decision is reached during the acquisition process.

The Committee on Appropriations of the House of Representatives in its Report No. 96-247 on the FY 1980 Appropriation Bill for Departments of State, Justice and Commerce, the Judiciary, and Related Agencies, commended NOAA for working jointly with the Federal Aviation Administration and the United States Air Force on an evaluation of the potential uses of single Doppler radar in weather forecasting and reporting. The Committee requested that NOAA submit the results of this review along with its FY 1981 budget request. The report was forwarded to the Committee in January 1980.

In March 1980, several contracts were let by the JSPO to conduct alternative system design concept studies for the purpose of defining and fine-tuning user requirements and to provide program management support for areas where expertise and experience were not available among the JSPO staff.

In April 1980, a Mission Need Statement was prepared in accordance with OMB Circular A-109. The Mission Need Statement represented the joint weather-related mission needs for an advanced weather radar with improved capabilities for detecting hazardous weather conditions. The Mission Need Statement was coordinated and agreed to by the participating departments and approved by the Secretary of Commerce in August 1980. Approval of the Mission Need Statement initiated the first major milestone and constituted the first key decision point in accordance with OMB Circular A-109.

In May 1980, development of a Joint Operational Requirements (JOR) began. The JOR represents a further expansion of the weather-related mission needs for each of the participating departments.

In June 1980, DOT's Federal Aviation Administration (FAA) let a contract to conduct a cost/benefit study to look at the benefits to be gained from an all-Doppler system versus a mix of Doppler and non-Doppler system. Preliminary results of this study were provided to OMB in September 1980. A draft report was delivered in February 1981.

The NEXRAD Program Council (NPC) also convened for the first time in June 1980. The NPC was formed to provide policy guidance to the NEXRAD JSPO and to resolve interagency differences and problems that cannot be resolved by the JSPO. The Deputy Federal Coordinator for Meteorological Services and Supporting Research is the Chairman of the Council with voice and no vote.

In September 1980, the Joint Program Development Plan (JPDP) was agreed to by the participating agencies and approved by the Assistant Secretary for Administration, DOC, who is the NEXRAD Acquisition Executive. The JPDP includes the scope of the NEXRAD program, summary of agency mission needs, acquisition strategy, the Program Manager's Charter, and an estimate of resource requirements. The acquisition strategy includes a four-phase acquisition process: (1) system definition; (2) competitive development validation; (3) full-scale development; and (4) full production.

Planned Activities for FY 1981

The NEXRAD Source Selection Evaluation Board (SSEB) was established by the Associate Administrator for NOAA, who is the Source Selection Official for the System Definition Phase contracts. The SSEB is made up of members from each of the participating agencies.

Other major plans for FY 1981 are to:

- Obtain approval for the Joint Operational Requirements.
- Increase the JSPO staff.
- Let short parallel contracts for alternative system design studies and program management support.

- Establish the Interim Operational Test Facility (IOTF) to test and demonstrate Doppler radar products in simulated and actual user environments. The results of these efforts will help the JSPO to better define the user requirements and to provide better guidance to the NEXRAD contractors so the full benefits of Doppler radar will be realized.

- Prepare and release solicitation documentation to industrial contractors and award multiple system definition phase contracts to those potential prime contractors who have or can provide those capabilities needed to successfully design, develop, and produce the full NEXRAD system. These contractors will examine alternative designs to meet the stated participating agencies' operational requirements, and will propose a specific design to be built and demonstrated during the validation phase that will provide the most effective solution.

The program to date has progressed steadily. Full coordination of all actions among the departments is slow and often difficult; however, the program is on schedule. The major problem in FY 1981 will be the development and coordination of the joint procurement specification. These vary from a system to provide data for forecast and warnings for DOC/NOAA, safeguarding DOD resources, and providing a major component to the National Aerospace System for DOT/FAA to promote aircraft safety by reliable bad weather aircraft separation and direction.

Automated Surface Observations

The Federal Aviation Administration (FAA) has agreed to assume the lead agency role in a joint agency program to develop and implement systems for the automation of surface weather observations. A draft program concept paper has been prepared and agency coordination has been requested. The draft concept provides for a joint program office to be established by the lead agency to plan and manage the program. The program office would function under the broad policy guidance and direction of a program council composed of members of the participating agencies and chaired without vote by the Deputy Federal Coordinator. Agency positions on this concept are not yet available.

A set of definitions of weather parameters will be established to accommodate automation. Sensor development continues with tests being conducted at Arcada, CA, and Dulles International Airport, VA, by the FAA. The National Weather Service (NWS) is conducting tests at Sterling, VA. The Transportation Systems Center, Cambridge, MA, is developing specifications and algorithms under joint FAA/NWS sponsorship.

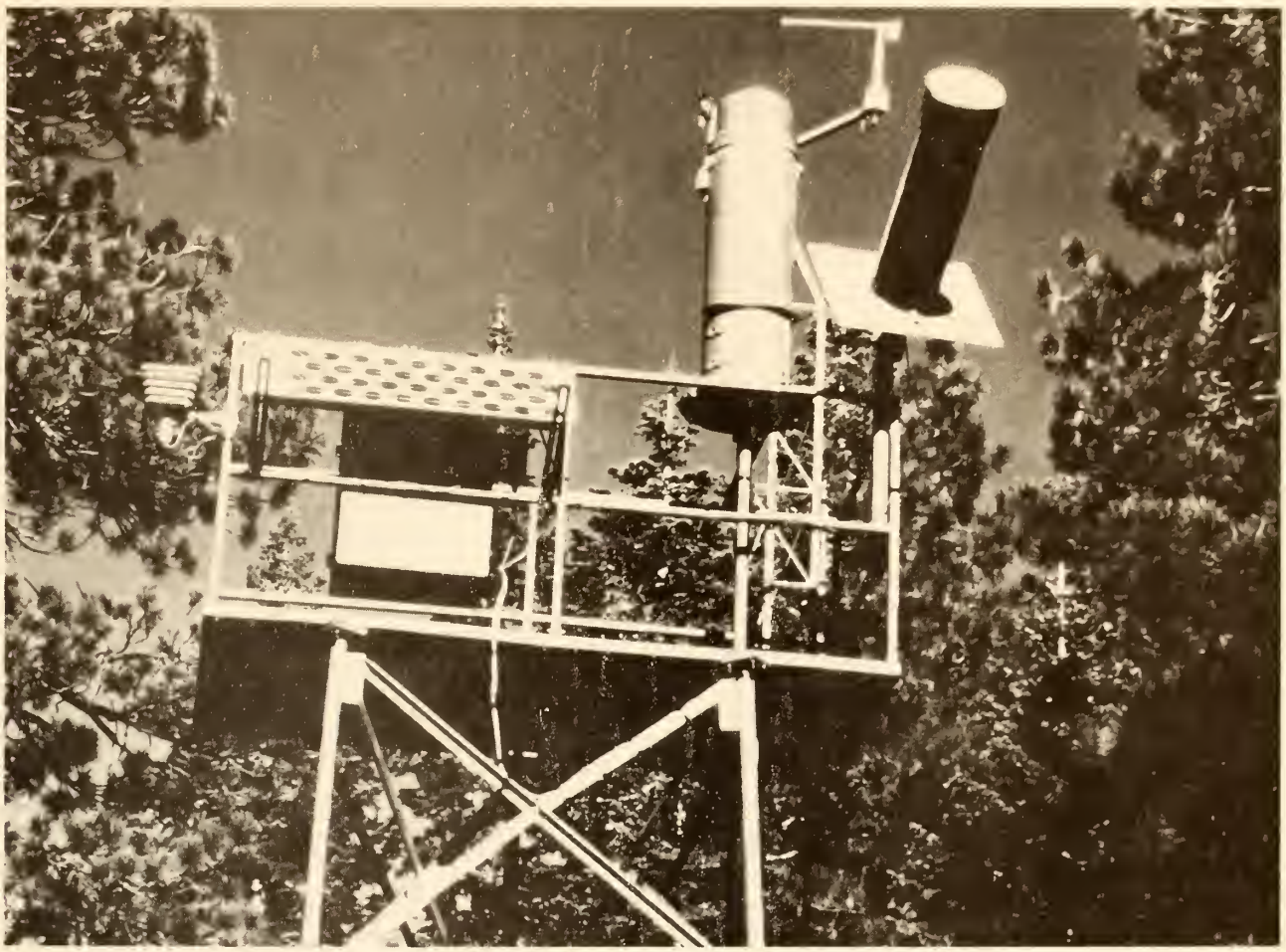
Planned Activities for FY 1981

- Obtain joint FAA, DOC and DOD approval of the program concept.

- Obtain joint FAA, DOC and DOD approval of the functional requirements.

- Continue contract design concept studies and program management support.

- Continue the development of the laser "Present Weather" sensor.



Automated, Solar-Powered Rain Gage

Networks of rain gages measure amounts of rain or snowfall reaching the ground. This gage is linked from remote locations to project sites by satellite and computer systems, and is solar powered (Department of Interior).

Automated Aircraft Reporting System

An experimental system called ASDAR (Aircraft to Satellite Data Relay), developed for the First Global Atmospheric Research Program Experiment held during 1978-1979, demonstrated the operational feasibility of automated aircraft reporting (AAR) of meteorological data. The objectives of this international research program are to extend the range, scope, and accuracy of weather forecasts, and to understand the physical basis of climate and climate fluctuations. However, the objective of the ASDAR part of the experiment was to acquire good, reliable, and timely data in sparse data areas to support the program.

ASDAR was so successful and beneficial to the major meteorological processing centers that the Working Group on Operational Processing Centers asked the Interdepartmental Committee on Meteorological Services and Supporting Research (ICMSSR) to keep the experimental system from being phased out, to develop a new generation of equipment suitable for commercial production, and to expand the system. The NASA, DOT, DOD, and DOC members of ICMSSR contributed funding and other resources to keep the current ASDAR system operating, and to study and plan for the expansion of the system. Studies found:

- That calculations based on typical operating parameters and flight routes indicate that there is a potential for saving tens of thousands of dollars per wide-bodied aircraft per year by instituting automated aircraft reporting of flight winds and temperatures. These data would be fed into numerical models to reduce wind and temperature forecast errors. For example, if improved forecasts resulted in a one percent saving in annual fuel consumption for a L-1011 aircraft, approximately $100,000 reduction in fuel costs per aircraft per year would result.

- That AAR equipment on board an aircraft can make possible a number of additional valuable functions including forward message weather advisory communication, ancillary real-time flight following, and the transmission of distress messages over Mayday frequencies.

- That AAR could provide wind and temperature profiles during aircraft ascent and descent near airports to help define potential hazardous wind shear and weather conditions.

- That AAR data could contribute to better meso- and synoptic-scale analysis and forecasting and could enhance the utility of satellite profile data by providing ground truth.

The Ad Hoc Group on Automated Aircraft Reporting (AHG/AAR), established by the ICMSSR, is the major forum for exchanging ideas, for identifying problems and discussing alternative solutions, for being a catalyst to solve immediate problems requiring interagency coordination and participation, for making contributions to the studies, and for developing a program development plan for an automated aircraft reporting system which will meet national and international requirements. The AHG/AAR has been effective in discovering ways to provide a better system to meet the needs of the broad meteorological community as well as to enhance aviation operations. An illustration of an AAR is shown in Figure 2.3.

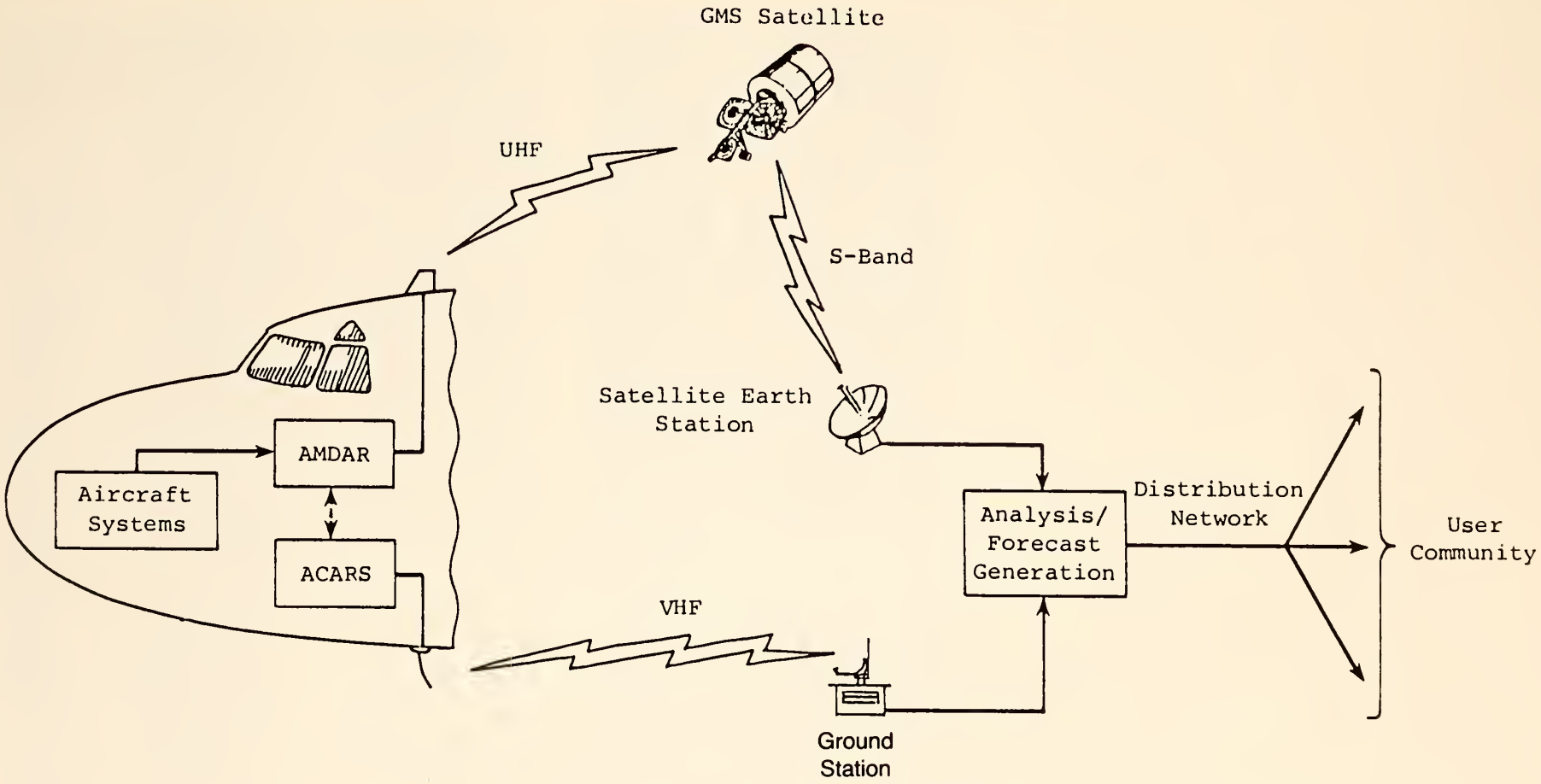


Figure 2.3 Automated Aircraft Reporting System

Planned Activities for FY 1981

- o Prepare a program development plan.
- o Perform additional ASDAR tests and evaluations.
- o Monitor current ASDAR operations.
- o Commence development of more detailed cost-benefit analyses.
- o Prepare recommendations to improve the quality and timeliness of aviation products and services.
- o Attempt to contract for a production model of the reengineered automated aircraft reporting system.

Improved Weather Reconnaissance System

The United States Air Force currently has 20 aircraft whose primary peacetime mission is hurricane and typhoon reconnaissance. The National Oceanic and Atmospheric Administration (NOAA) reimburses the USAF for operational missions that support the National Hurricane Center (NHC) and the National Meteorological Center (NMC). The National Weather Service (NWS) has stated a need for high-precision reconnaissance data, especially during the 48-hour period prior to landfall. This cannot be met today because only the three NOAA research aircraft have the instrumentation to provide the necessary information.

The Federal Coordinator for Meteorological Services and Supporting Research and the National Academy of Sciences have studied the forecasting problem and the need for aircraft data. They concluded that an improved reconnaissance capability is essential for current operational forecasting and to provide the data required for the 1980's and beyond for new meteorological models of the NMC.

In October 1975, OMB asked the DOC and DOD to coordinate the modernization of reconnaissance aircraft to arrange for joint funding. The initial and subsequent programs to meet these needs have not been included in the funding levels of either department. Consequently, the current aircraft instrumentation system is essentially the same as it was fifteen years ago. It is manual and lacks the accuracy, reliability, and sampling frequency needed for new hurricane prediction models.

The USAF and NOAA are exploring another program to partially meet these weather reconnaissance needs. The program has been proposed to consist of inertial navigation equipment, air-to-ground communications using satellites, data recorders, and message composers. The data processing and communications of the program have been designated the Atmospheric Distributed Data System (ADDS).

Planned Activities for FY 1981

- o Install the prototype system on an Air Force WC-130.

- o Evaluate concept feasibility, begin conducting flight tests, and conduct an operational evaluation.

- o Consider a joint DOC/DOD plan for acquisition and follow-on systems if the prototype meets requirements.

Crosscut Analyses

In FY 1980, the Office of the Federal Coordinator completed a review of the operational capabilities of the three meteorological forecast centers that operate within the Federal Government. Each of these centers, operated by the National Weather Service, the Navy and the Air Force, provides basic services. However, their primary mission is the special requirements that each must satisfy. The Federal Coordinator also completed a review of Federal agency roles, missions, and programs.

Numerical Processing Centers

The subject report includes the results of comparisons of the three processing centers and points out the significantly different mission requirements. The mission of the National Weather Service's center is to provide basic guidance support to forecast offices, whereas the Air Force center provides direct support to users and supports specific applications. The U.S. Navy's oceanographic processing center has a mix of basic guidance, direct support to users, and specific applications. Appendices to the report include technology projections and issues arising from the new and growing data bases.

Following the comparisons of the three processing centers (NOAA, USAF and USN), the study identifies alternative configurations for the centers in the late 1980's and early 1990's. These configurations differ in the degree of consolidation and integration envisaged. The study also identifies and examines alternative steps or "paths" to reach these configurations.

The study concludes that satisfying requirements in light of technological developments with constrained resources will eventually force the three centers toward a more coordinated effort. Also, it is concluded "that a logical first step could be to establish a 'Centers of Specialization' option between two of the centers." Broad-band communications linking the centers, assuming such could be obtained, would allow the timely exchange of the specialized analyses and products. The agencies all agree that the rapid changes in technology introduce uncertainties, as well as opportunities, and that there is insufficient information available at this time to identify a clearly optimum configuration for the early 1990's. Furthermore, failure to consider adequately the unique Defense requirements concerning wartime support and military contingencies substantially weakens the discussion of alternative configurations. A very serious limitation raised by Defense was that the report failed to "recognize that optimization for peacetime may result in failure during wartime." A consensus seems to be that the agencies should move in a step-by-step manner to increase the exchange of products and to provide backup of selected products among the centers. Under a current Memorandum of Understanding for meteorological satellite support, the agencies have already started to move toward the centers of specialization concept. The exchanged data products will replace and supplement existing products for use by each center's customers.

In FY 1981, the Office of the Federal Coordinator will continue to review the numerical processing centers' operations to identify additional areas of potential cooperation among the centers.

Federal Agency Roles and Missions

The report includes the agencies' statutory authorities; agency plans and programs in the 1980's; interagency agreements; agency views on technology, coordinating mechanisms, and the role of the private sector; and a review of OMB Circular A-62. The report also provides policy considerations in the form of "Assessments, Observations, and Options".

The study concludes that current authorities appear to cover the needs of the agencies, that OMB Circular A-62 is sufficiently broad to meet current needs, and that there appears to be no need to amend it at this time. In regard to the location of the Office of the Federal Coordinator (OFCM) in the Executive Branch, the study identifies four options for locating the OFCM in NOAA. The first option is to continue the present arrangement whereby the Office of the Federal Coordinator is assigned to the Assistant Administrator for Oceanic and Atmospheric Services, so long as the National Weather Service remains in its present location in the NOAA organization. Other options identified include making the OFCM a staff office to the Deputy or Associate Administrator or to the Administrator.

In line with the study suggestion, the Federal Plan for FY 1982 includes a separate section to reflect the extent and type of coordination among agencies. As suggested in the report, efforts are being made to have the Agricultural Weather Plan prepared jointly in 1981 by the Department of Agriculture and the National Weather Service. The study concludes that coordination of meteorological research and development is difficult and time-consuming and that significant parts of it are being coordinated by offices other than the OFCM. The study discusses the possible scope for coordinating research and development, and concludes that the greatest potential for payoff is to coordinate that development which is under consideration for operational implementation. The OFCM has been emphasizing coordination of the latter type of development--next generation radar (NEXRAD), automated observing systems, and automated weather information handling systems.

The study includes a discussion of agency systems and plans for automated weather collection and distribution systems. The study points out that agencies have proceeded on separate developments because of differing mission requirements and sees a possibility for significant economies if agency requirements can be satisfied by a joint development. A working group under the ICMSSR has concluded in a recent report that the differing mission requirements cannot be satisfied economically by a common system. The group concluded that economies can be achieved by use of off-the-shelf technology and by the adoption of standard interfaces and operating procedures.

In regard to aviation terminal forecasts, the study concludes that skilled meteorologists will play an important role for many years and will be critically needed to prepare mission-tailored analyses and forecasts.

In FY 1981, the Office of the Federal Coordinator will selectively review and coordinate areas that are highlighted in the study.

Meteorological Planning for Emergencies

At the request of the Federal Emergency Management Agency (FEMA), ICMSSR agreed to review the problem of coordinating meteorological activities associated with radiological and other emergencies. After an exploration meeting of interested agencies, an Ad Hoc Group on Meteorological Planning for Emergencies was formed to be the principal means for coordinating and monitoring overall meteorological planning for emergencies until these responsibilities can be phased into the existing or planned Federal meteorological coordination framework.

Since nuclear incidents were of immediate and paramount concern, two additional groups were formed. One group will develop specific Meteorological Plans for Radiological Emergency Responses (MPRER), while the other deals with atmospheric transport models. The response plan group has begun to identify interagency agreements, understandings, and directives to determine requirements and to establish interagency notification and coordination contacts. It has also begun to establish procedures to be used when a nuclear incident is declared.

The transport model group was established to develop and maintain a plan for the identification, selection, and monitoring of models, for establishing and maintaining standard test and evaluation procedures, and for establishing criteria for model input and output requirements.

The request by FEMA to look at the emergency response problems has been a catalyst which opened new coordination channels among agencies involved in providing Federal assistance during emergencies. It has also helped to bring focus within agencies. The existing Federal coordination mechanism again has demonstrated its effectiveness and usefulness. However, this can be attributed to the excellent support provided by the agencies involved.

Planned Activities for FY 1981

- o Develop a plan for coordinating meteorological activities related to all emergencies.
- o Prepare an initial plan for responding to radiological emergencies.
- o Develop input and output requirements for quick response radiological transport models.

Automated Weather Information Systems

The GAO, in its October 16, 1979, Report to the Congress, stated that overlapping Federal weather programs have concerned both the Congress and the OMB for more than a decade. The GAO also stated that the current renewed interest and crosscut reviews, plus special coordination activities underway, are actions which hopefully will resolve some of the concerns raised.

One of concerns raised in the report involves development of weather systems, such as Automation of Field Operations and Services (AFOS) and Naval Environmental Display Stations (NEDS) to automate the transmission and display

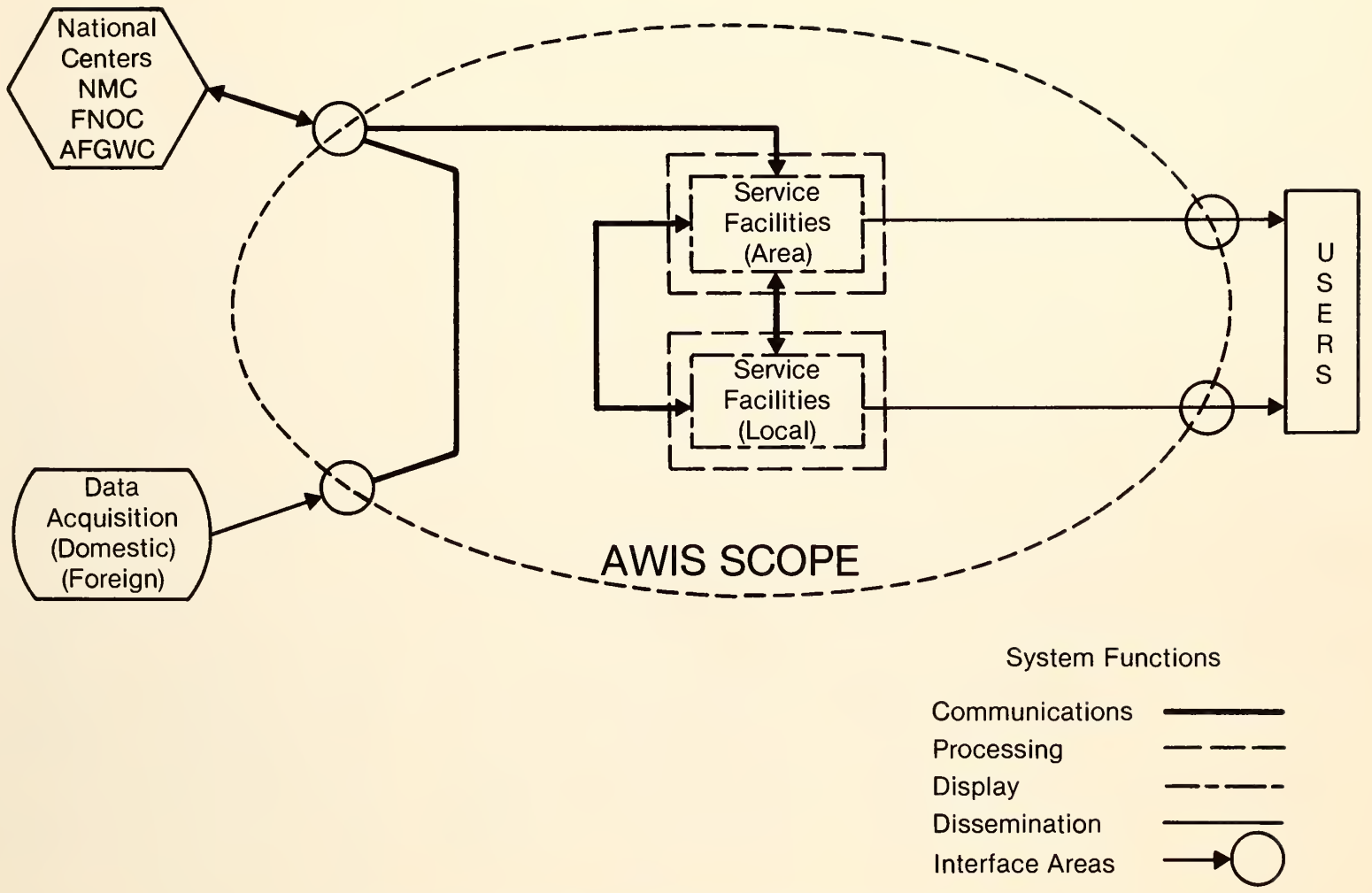


Figure 2.4 Automated Weather Information System (AWIS).

of weather charts and forecasts. In response to this concern, the Federal Coordinator asked ICMSSR to examine the adequacy of interagency coordination and possibilities for savings through joint development and procurement actions involving these systems. As a result, the Working Group on Automated Weather Information Systems (WG/AWIS) was established under the ICMSSR Subcommittee on Systems Development to prepare a crosscut-type report involving such systems and to effect continuing coordination on the planning, development, and implementation of new weather information systems and major system architectural changes thereto.

The WG/AWIS prepared a report requested by the Federal Coordinator and recommended that the agencies separately procure major weather information system components most compatible with individual missions and modes of operation, that agencies effect life-cycle economies through the procurement of technology with proven broad-market acceptability to the maximum possible extent, and that agencies introduce economy and efficiency in operations of individual systems through mutually agreed-upon standards in system specifications and standing operating procedures and practices. The DOC/NWS, DOT/FAA, DOD/AWS, and DOD/NOC jointly prepared the report.

The group initiated coordination of interface specifications and common subfunctions specifically for the interface between the NWS' AFOS and the Navy's NEDS systems with the view that coordination should also involve the AWS and the FAA. The proposed boundaries and interfaces of an AWIS system is shown in Figure 2.4.

Planned Activities for FY 1981

- o Establish an activity to develop standards and guidelines for use in weather information systems.
- o Establish a working relationship with the National Bureau of Standards to integrate meteorological program standards and guidelines into the overall Federal Information Processing Standards Program.
- o Identify interfaces and subfunctions which can be standardized and establish priorities for developing standards and guidelines for them.
- o Coordinate automated weather information system activities and propose recommendations to improve the efficiency and effectiveness of these systems.

Activities Under Consideration by the Office of the Federal Coordinator FY 1982 and Beyond

There are a number of other Federal weather activity issues which should be addressed in FY 1982 and subsequent years. These are areas identified by one or more agencies as potential problems or where further analyses are required to develop and acquire information essential to future planning.

New Weather Service Needs. What new weather services are going to be required by the Nation in the coming 10-15 years? Who will require them, and what benefits will the Nation as a whole derive from them? How should these services be provided and how should they be financed? What research and development will be necessary?

The Role of New Technology in Weather Services. What new technology is or will become available in the next 10-15 years, either to improve the quality of weather services or the efficiency of the programs? What actions are being taken or planned to develop this technology? What will it cost to develop and implement? What will be the benefits to users and to the Government?

Public and Private Roles. What are appropriate roles for Federal, state, local, and private sectors in providing weather services and conducting rsearch and development? Which functions and services are clearly a Federal responsibility? Which are clearly the province of the private sector? Which can be either Federal or other? How should the Federal functions be financed? How should Federal costs be apportioned among the Federal agencies performing the services or deriving benefits therefrom?

To address these issues, the Office of the Federal Coordinator has a number of evaluations and other studies in the planning stage or under consideration. Among these are:

- o An assessment of the weather services required by the Nation in the future, how these services should be provided, and how they might be financed in order to provide a coherent framework for evaluation of services.

- o An evaluation of the role new technology could serve in the improvement of weather services. Its focus would be long-range considerations for agencies in evolving their weather service.

Additional tasks under consideration for the Federal Coordinator are listed below:

- o Undertake a comprehensive study of overall Federal requirements for weather observations before the generation of an implementation plan for the establishment of automatic surface observing stations.

- o Develop a data base upon which to build answers to such questions as:

  - Are agencies maintaining or developing capabilities to satisfy their own needs without considering the capabilities and requirements of other agencies?

  - How much functionally similar activity is there among weather services provided by NWS, Navy and AWS, and is that which exists necessary?

- o Assess the need for the Federal provision of enhanced weather services during the next 10 to 15 years.

- o Undertake a comprehensive review of the role of the Federal Government in providing specialized weather services. What should be the role of the private meteorological industry in providing such services?

- o Preparation of issue papers and decision memoranda for consideration by the Federal Committee for Meteorological Services and Supporting Research.

SECTION 3

RESOURCE INFORMATION AND ANALYSIS

The resource information in this Plan is based on President Reagan's FY 1982 budget request as of March 10, 1981. The revised FY 1982 budget request is about 10 per cent below the amount requested in the January 1981 budget submitted by President Carter for meteorological services and supporting research.

A compilation of agencies' weather activities is found in Appendix B to this Plan. Appendix B also includes the activities of agencies that are not normally required to submit resource information for inclusion in this Plan.

AGENCY OBLIGATIONS FOR METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH

Table 3.1 summarizes funding for meteorological operations and supporting research for FY 1981 and the agencies' requests for FY 1982. Figure 3.1 is a graphic summary of Table 3.1. Table 3.1 shows that agencies plan to spend approximately $973.9 million in FY 1981, and have requested $1.1 billion for FY 1982. This represents a net increase of $112.2 million or 12 percent. The most significant program changes by agency are discussed in the following paragraphs.

Department of Agriculture (USDA)

There are no significant increases or decreases in USDA meteorological operations or supporting research. The funding amounts shown have been increased slightly to reflect changes in categorization of some activities in the U.S. Forest Service and in the Science and Education Administration.

Department of Commerce (DOC)

The National Oceanic and Atmospheric Administration (NOAA) is requesting an overall increase of $41.0 million from FY 1981 to FY 1982 for operational and supporting research costs.

1. For its Basic Environmental Services activity, NOAA is requesting increases totaling $10.6 million to complete the procurement and installation of the fully automated surface weather observing system ($2.0 million); to support development of a Next Generation Radar (NEXRAD) system ($4.1 million); to upgrade the large-scale computational facility at Suitland ($1.5 million); and to procure a new computer system at the Environmental Research Laboratories ($3.0 million).

Decreases totaling $4.8 million resulting from the termination of the radar data processors (RADAP) equipment ($3.4 million); from scheduled computer savings ($0.4 million); and as a result of the reduction in the overall services, accounted for in this activity, associated with a proposed closing of 38 part-time Weather Service Offices and conversion of eight Weather Service Forecast Offices to a reduced status ($1.0 million).

2. In the Environmental Satellite Services activity, NOAA requested increases of $47.8 million to provide funds for: procurement of NOAA H and I polar-orbiting spacecraft ($28.6 million); procurement of GOES G and H geostationary spacecraft ($9.1 million); and reimbursement to NASA for launch services for GOES D, E and F spacecraft ($10.1 million).

Decreases of $9.0 million result from scheduled proposed adjustments in funding levels in the polar-orbiting spacecraft program ($6.8 million); geostationary spacecraft program ($1.8 million); and continued planned reductions in computer support funding ($0.4 million).

The deletions of proposed funding for the National Ocean Satellite System ($16.0 million) represent the major change occurring in this budget activity when compared to the January budget.

The funds deleted associated with the National Ocean Satellite Systems included reimbursement to NASA for developing and launching the prototype spacecraft ($8.6 million) and for related ground and data systems development ($7.4 million).

3. A requested increase of $7.0 million for Public Forecast and Warning Services will complete deployment of the initial Automation of Field Operations and Services (AFOS) site network, implement needed enhancements to the initial field systems, and implement an advanced communications system.

A decrease of $0.7 million in this activity is associated with the proposed closing of 38 part-time Weather Service Offices (WSO's) and the conversion of eight Weather Service Forecast Offices (WSFO's) to reduced status.

4. An increase of $0.4 million is requested to establish a basic users climatological data base.

Decreases of $0.3 million result from the proposed discontinuation of selected climatic publications; reductions in oceanographic center support; reduced review of environmental documents; the elimination of the marketing and user service education program; and termination of support for the Regional Coastal Information Centers program which is being discontinued.

Department of Defense (DOD)

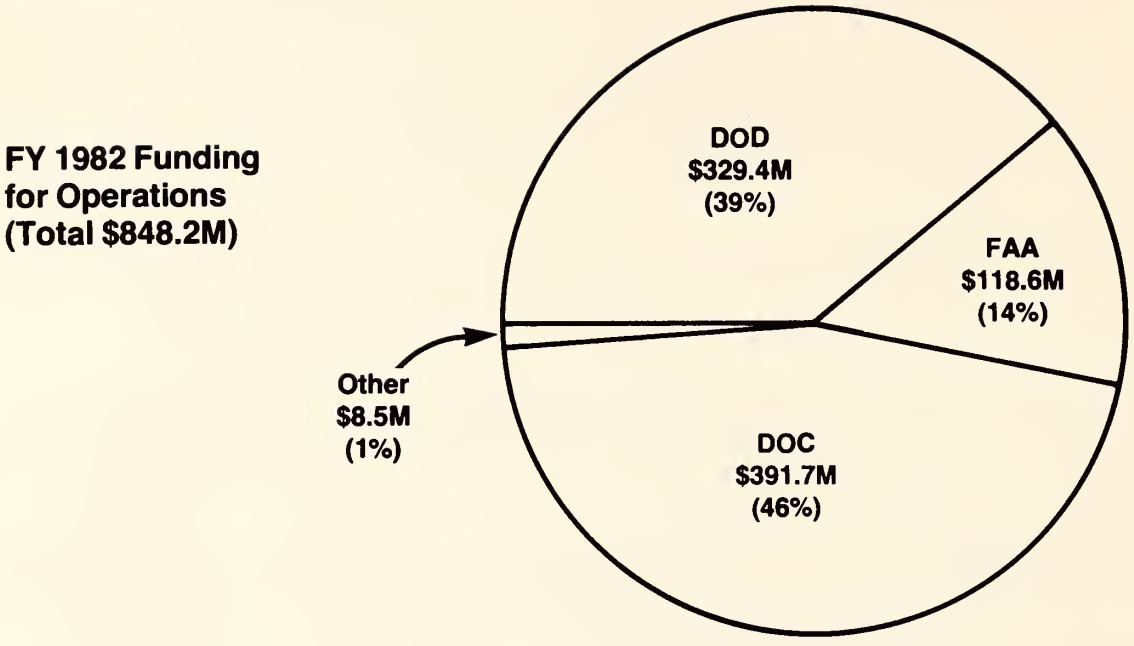
From FY 1981 to FY 1982, the Department of Defense is requesting an overall increase of $57.4 million for operational and supporting research costs. The significant program changes for the U. S. Air Force, Army and Navy are described below:

1. The U. S. Air Force is planning a net increase of $13.1 million for operating costs:

a. For the observing category, the Air Force is planning a net increase of $1.2 million; increases totaling $9.6 million for equipment procurement and increased operating expenses; with a decrease of $8.4 million for a reduction in procurement costs for the Defense Meteorological Satellite Program (DMSP) plus miscellaneous decreases.

TABLE 3.1
METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH, BY AGENCY
(Thousands of Dollars)

Agency	OPERATIONS			SUPPORTING RESEARCH			TOTAL		
	FY81	FY82	Net Difference	FY81	FY82	Net Difference	FY81	FY82	Net Difference
Agriculture	1,106	1,118	+ 12	6,594	6,781	+ 187	7,700	7,899	+ 199
Commerce	352,718	391,655	+ 38,937	32,876	34,966	+ 2,090	385,594	426,621	+ 41,027
Defense	305,811	329,450	+ 23,639	66,089	99,800	+ 33,711	371,900	429,250	+ 57,350
Energy	3,824	4,280	+ 456	-	-	-	3,824	4,280	+ 456
Transportation/ US Coast Guard	1,547	1,624	+ 77	-	-	-	1,547	1,624	+ 77
Transportation/ FAA	119,980	118,618	- 1,362	13,365	16,535	+ 3,170	133,345	135,153	+ 1,808
EPA	500	500	0	8,000	7,000	- 1,000	8,500	7,500	- 1,000
NASA	786	991	+ 205	60,000	72,000	+ 12,000	60,786	72,991	+ 12,205
NSF	-	-	-	700	750	+ 50	700	750	+ 50
TOTAL	786,272	848,236	+ 61,964	187,624	237,832	+ 50,208	973,896	1,086,068	+ 112,172



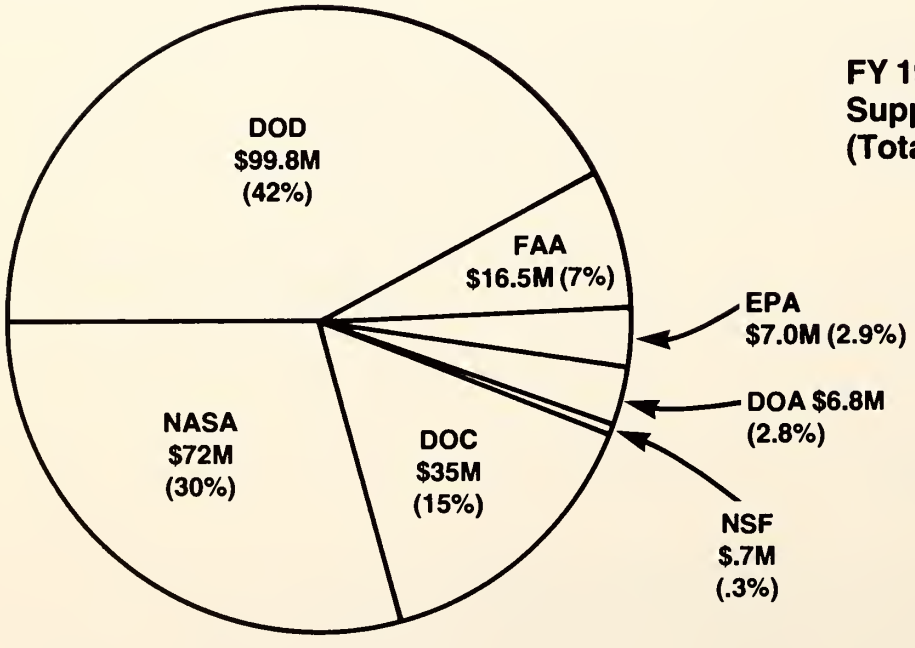


Figure 3.1 Graphic comparison of FY 1982 Funding by Agency. (Based on Table 3.1)

b. For the analysis and forecasting category there will be a net decrease of $1.9 million. Increases totaling $6.3 million for the Air Force Global Weather Center (AFGWC) operations will be offset by a decrease of $8.2 million due to the completion of the Interactive Processing and Display System (IPADS).

c. For communications and dissemination to users, the Air Force is expecting a total increase of $8.0 million for operating costs; and for general agency support, increased operating costs will be about $5.8 million.

2. The U. S. Army is planning an increase of $7.6 million to modernize its Field Artillery Meteorological Acquisition Systems.

3. The U. S. Navy is planning a net increase of $3.3 million for FY 1982:

a. A net increase of $0.5 million for satellite equipment procurement.

b. An increase of $0.6 million to procure and upgrade ADP equipment.

c. For communications and dissemination categories, there will be a net increase of $1.9 million for leasing facsimile equipment, procuring additional Naval Environmental Display Systems (NEDS), and the escalation in overall operating costs.

d. For general agency support, the Navy anticipates an increase of $0.3 million.

Department of Energy (DOE)

The Department of Energy reported no significant changes for FY 1982.

Department of Transportation (DOT)

Program changes from FY 1981 to FY 1982 within DOT are presented for the Federal Aviation Administration (FAA) and the U. S. Coast Guard (USCG).

1. The FAA is planning a net increase of $1.8 million for FY 1982. There will be an increase of $3.2 million for supporting research in aviation services which will be partially offset by a decrease of $1.4 million for overall operating expenses.

2. The USCG is anticipating a net increase of $0.1 million for maintenance support operations. A decrease of about $25 thousand will be due to the automation of six Coast Guard light stations.

Environmental Protection Agency (EPA)

The Environmental Protection Agency is planning to complete its studies of prolonged elevated pollution and northeast oxidants episodes. This will permit a reduction of $1.0 million in FY 1982.

EPA's applied research is in the areas of air quality dispersion model development, evaluation, verification, and application; development and application of air pollution climatology; determination and description of pollutant effects on atmospheric parameters; and determination of meteorological effects on air quality. Dispersion models for inert and reactive pollutants are under development and evaluation on all temporal and spatial scales. Particular emphasis is being given to the development of a dispersion model for use in complex terrain, and photochemical air quality dispersion models on several scales utilizing data collected during earlier field programs. These programs initiated in FY 1980 are also prime research projects in FY 1982. Planetary and urban boundary layer models are under development for use with air quality dispersion models. Examination of the relationship between meteorology and air quality, with emphasis on ozone and sulfates, continues. The effects of air pollutants on atmospheric parameters, such as visibility and precipitation chemistry, are also under continuing investigation.

National Aeronautics and Space Administration (NASA)

The National Aeronautics and Space Administration is planning a net increase of $12.2 million primarily for supporting research.

The goals of the NASA Weather and Climate Research Program are to observe and study the atmosphere and the Earth from the unique perspective of space in order to increase understanding of the atmosphere and to improve the ability to predict its future state. These goals are pursued through the development of: new sensors; new space and ground systems; new techniques to process, interpret and verify satellite data; new analytical procedures; and advanced models to utilize the data diagnostically and prognostically. Programmatically, these supporting research activities are managed under three elements as follows:

- Development of space and ground systems for severe storm detection, monitoring, prediction, and warning.
- Development of space and ground systems to improve our monitoring of global weather and our mid-range forecast capability (3-14 days).
- Investigation of the potential of space technology for monitoring and predicting climate variability.

A detailed discussion of NASA's research program is covered in Appendix B.

National Science Foundation (NSF)

The NSF funding in FY 1982 for supporting research will be level funded from FY 1981--an increase of $50 thousand for increased operating costs. As of FY 1981, the Atmospheric Sciences Division of the National Science Foundation began reporting basic research activities which would ultimately improve either basic or specialized meteorological services. The initiation of these reports arises from a reexamination of the Foundation's programs and not from any significant increase in the amounts provided for that research.

The NSF supports meteorological research primarily at universities and non-profit institutions. Although the research is largely basic in character, there are portions of three programs that could ultimately improve either basic or

specialized meteorological services. The three programs are: (1) Meteorology; (2) Experimental Meteorology and Weather Modification; and (3) the Global Atmospheric Research Program (GARP). GARP is an international effort to obtain basic knowledge that should ultimately improve weather forecasting.

AGENCY OPERATIONAL COSTS BY FUNCTION

Table 3.2 shows how the agencies plan to obligate their funds for the five major operational functions involved in meteorological service operations. Brief descriptions of the activities included in each of these major functions are provided for a more detailed understanding.

Observations

This function involves obtaining data that define the physical and sensible states of the atmosphere. These data underlie all weather forecasts and warnings as well as supporting aircraft and ship operations. The observing function is divided into five program elements for planning and coordinating Federal meteorological operations. These are: surface, upper air, weather reconnaissance, weather radar, and operational environmental satellite observing programs.

Analyses and Forecasts

The analysis and forecast function involves centralized production of manual and computerized analyses of meteorological data as well as projections of the future states of the atmosphere and accompanying weather phenomena. For purposes of planning and coordinating programs, this function is divided into three parts:

- Analyses and forecasts on a global and hemispheric basis are prepared in Primary Centers;
- Products of Primary Centers are tailored for specific areas or user groups by area or guidance centers; and
- Specific weather phenomena, such as hurricanes and severe thunderstorms, are dealt with by specialized centers.

Communications

Meteorological operations require moving very large amounts of data and information from the observation sites to the processing centers and then disseminating products to users. The communications function cost includes all costs for all types of communication equipment and services used for these purposes.

Dissemination to Users

This function represents the final step in preparing and delivering weather service products to the users. The field offices of DOC and DOD and the flight service stations of DOT are the principal program elements involved.

General Agency Support

Operation of the Federal Weather programs involves the planning, training, maintenance, and management activities common to any large activity, Government or private sector. Many of these activities are particularly demanding for weather service operations because of the highly dispersed field office structures and the need for very high levels of operational reliability. For purposes of planning and coordinating Federal weather activities, the general support function is divided into internal support and planning, engineering and mission-related work, maintenance of equipment and facilities, training of personnel, and overall program management.

Table 3.2 shows that the agencies devote about 38 percent of their resources to observations on a sustaining basis. The principal changes year-to-year are associated with cyclic variations in satellite procurements and with costs for new equipment such as automatic weather observing stations and weather radars. Approximately 18 percent is devoted to analyses and forecasts where the major year-to-year changes are the result of replacing the computers that are the keystone of the operations. Communications costs, comprising about 10 percent of the total program, are usually stable year-to-year, reflecting the long-term nature of communications systems planning, engineering and operation. The dissemination to users function is also usually stable from year-to-year at about 16 percent because the field office structures are not subject to large changes. General agency support requiring the remaining 18 percent is subject to some significant year-to-year variations, especially in maintenance and training activities.

AGENCY SUPPORTING RESEARCH COSTS

Table 3.3 shows how the agencies plan to obligate their funds for supporting research in the four functional areas used for planning and coordinating programs.

The supporting research functions do not differ greatly from those discussed previously for operational programs. The observation and dissemination functions are identical and the "description and prediction" function equates to "analyses and forecasts". The research function of "systems and support" covers the development and engineering research work related to maintenance, training, and engineering operations.

Supporting research programs characteristically are stable year-to-year unless a major project is initiated or terminated by one or more of the agencies.

TABLE 3.2
AGENCY OPERATIONAL COSTS, BY FUNCTION
(Thousands of Dollars)

AGENCY	Observations		Analyses and Forecasts		Communications		Dissemination to Users		General Agency Support		Total	
	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82
Agriculture	650	650	60	60	-	-	346	358	50	50	1,106	1,118
Commerce	112,509	157,272	93,651	102,150	10,817	11,735	42,523	50,901	93,218	69,597	352,718	391,655
Defense	129,338	138,134	48,998	47,662	27,483	34,374	45,781	48,924	54,211	60,356	305,811	329,450
Energy	1,492	1,669	382	428	38	43	268	300	1,644	1,840	3,824	4,280
Transportation/ US Coast Guard	410	402	-	-	205	201	45	45	887	976	1,547	1,624
Transportation/ FAA	24,155	22,981	-	-	37,622	37,015	35,846	35,432	22,357	23,190	119,980	118,618
EPA	-	-	500	500	-	-	-	-	-	-	500	500
NASA	52	56	378	510	70	77	10	10	276	338	786	991
NSF	- Not Applicable -											
TOTAL	268,606	321,164	143,969	151,310	76,235	83,445	124,819	135,970	172,643	156,347	786,272	848,236

TABLE 3.3
AGENCY SUPPORTING RESEARCH COSTS, BY FUNCTION
(Thousands of Dollars)

AGENCY	Observations		Description and Prediction		Dissemination		Systems and Support		Total	
	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82
Agriculture	-	-	1,347	1,347	185	210	5,062	5,224	6,594	6,781
Commerce	9,060	8,949	17,662	18,232	-	-	6,154	7,785	32,876	34,966
Defense	36,826	66,158	18,240	20,496	1,179	1,263	9,844	11,883	66,089	99,800
Energy	- Not Applicable -									
Transportation/ US Coast Guard	- Not Applicable -									
Transportation/ FAA	3,200	7,875	500	325	6,345	5,260	3,320	3,075	13,365	16,535
EPA	-	-	8,000	7,000	-	-	-	-	8,000	7,000
NASA	46,400	58,100	13,200	13,300	-	-	400	600	60,000	72,000
NSF	-	-	700	750	-	-	-	-	700	750
TOTAL	95,486	141,082	59,649	61,450	7,709	6,733	24,780	28,567	187,624	237,832

METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH BY SERVICE

Tables 3.4 and 3.5 show how the agencies plan to obligate funds for basic and specialized meteorological services and corresponding supporting research. The tables show that the agencies devote approximately 49 percent of their resources to basic services and 51 percent to specialized services. The definitions of basic and specialized services are provided below for your convenience.

Basic Services

All activities that are possible within the given state of meteorological science required to produce or complete a description in time and space of the atmosphere. In general, the products of this process are meteorological in nature and not necessarily useful in such form for the operational needs of users. These services also include those activities required to derive from raw data the products needed by the general public in their normal everyday activities and the protection of their lives and property.

The general functions involved in providing basic meteorological services include:

- Measurement of the meteorological characteristics of the atmosphere made with sufficient density and frequency to meet the needs of the general public and the common needs of all users.
- Collection of these measurements for processing.
- Analyses and prognoses of meteorological variables and interpretation of the analyses and prognoses for meeting the needs of the general public.
- Distribution of these meteorological analyses and prognoses to outlets for subsequent interpretation for the operational needs of all users, and the distribution and display of operational products to meet the needs of the general public.

Specialized Services

Those activities, derived generally from the output of the basic meteorological services, which produce those products needed to serve the operational needs of particular user groups. These user groups include, among others, aviation, agriculture, commerce, and military.

The general functions involved in providing these services include:

- Establishing parameters needed to serve solely a particular operational purpose.
- Collecting data from specialized measurements which conform with the established parameters.
- Analyzing the data obtained from specialized measurements.

TABLE 3.4

AGENCY OPERATIONAL COSTS, BY SERVICE
(Thousands of Dollars)

AGENCY	Basic		Aviation		Marine		Agriculture and Forestry		General Military		Other		TOTAL	
	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82
Agriculture	-	-	-	-	-	-	1,106	1,118	-	-	-	-	1,106	1,118
Commerce	319,614	356,097	22,335	22,296	3,395	3,622	6,537	6,811	-	-	837	2,829	352,718	391,655
Defense														
Air Force	40,072	41,394	152,772	162,636	-	-	-	-	35,063	36,219	22,540	23,284	250,447	263,533
Army	-	-	-	-	-	-	-	-	8,537	16,748	-	-	8,537	16,748
Navy	6,278	6,474	14,598	16,810	9,703	8,379	-	-	11,707	12,695	4,541	4,811	46,827	49,169
Energy	-	-	-	-	-	-	-	-	-	-	3,824	4,280	3,824	4,280
Transportation/ US Coast Guard	1,036	1,094	-	-	511	530	-	-	-	-	-	-	1,547	1,624
Transportation/ FAA	9,903	10,374	110,077	108,244	-	-	-	-	-	-	-	-	119,980	118,618
EPA	-	-	-	-	-	-	-	-	-	-	500	500	500	500
NASA	-	-	-	-	-	-	-	-	-	-	786	991	786	991
NSF	- Not Applicable -													
TOTAL	376,903	415,433	299,782	309,986	13,609	12,531	7,643	7,929	55,307	65,662	33,028	36,695	786,272	848,236

TABLE 3.5
AGENCY SUPPORTING RESEARCH, BY SERVICE
(Thousands of Dollars)

AGENCY	Basic		Aviation		Marine		Agriculture and Forestry		General Military		Other		TOTAL	
	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82
Agriculture	-	-	-	-	-	-	6,594	6,781	-	-	-	-	6,594	6,781
Commerce	30,373	32,437	968	979	1,518	1,533	17	17	-	-	-	-	32,876	34,966
Defense	6,313	6,806	1,800	2,300	4,600	5,500	-	-	53,376	85,194	-	-	66,089	99,800
Energy	- Not Applicable -													
Transportation/ US Coast Guard	- Not Applicable -													
Transportation/ FAA	-	-	13,365	16,535	-	-	-	-	-	-	-	-	13,365	16,535
EPA	-	-	-	-	-	-	-	-	-	-	8,000	7,000	8,000	7,000
NASA	59,726	71,900	80	-	-	-	194	100	-	-	-	-	60,000	72,000
NSF	700	750	-	-	-	-	-	-	-	-	-	-	700	750
TOTAL	97,112	111,893	16,213	19,814	6,118	7,033	6,805	6,898	53,376	85,194	8,000	7,000	187,624	237,832

- Interpreting the analyzed data and making prognoses to meet the operational needs of users.

- Distributing and displaying these specialized products to meet the needs of individual users or groups.

For purposes of Federal planning and coordinating, Specialized Services are:

- Aviation Meteorological Services: Those services and facilities established to meet the requirements of general, commercial and military aviation. Civil programs are included that are directly related to services solely for civil and military programs in support of fixed and rotary wing aircraft and medium or long-range missile operations.

- Marine Meteorological Services: Those services and facilities established to meet the requirements of Commerce and Defense on the high seas, coastal and inland waters and for boating activities in coastal and inland waters. The civil programs which are directly related to services solely for marine uses and military programs supporting fleet, amphibious and sea-borne units (including carrier-based aviation and fleet missile systems) are included.

- Agriculture and Forestry Meteorological Services: Those services and facilities established to meet the requirements of the agricultural industries and Federal, State and local agencies charged with the protection and maintenance of the Nation's forests. The agricultural, large-area crop inventory programs and fruit-frost programs of the Department of Commerce are included.

- General Military Meteorological Service: Those services and facilities established to meet the requirements of military user commands and their component elements. Programs and services which are part of Basic, Aviation, Marine or Other Specialized Services are not included here.

- Other Specialized Meteorological Services: Those services and facilities established to meet requirements of user agencies or groups not included in the preceding categories, such as support to: civil and military programs involving space operations; Federal, State and local governmental agencies responsible for dealing with urban air pollution; schools or training programs; R&D in areas other than space; and small agency programs for services. Department of Energy programs for these specialized meteorological services are included.

AGENCY STAFF ENGAGED IN WEATHER OPERATIONS

Table 3.6 shows how agency staff resources are distributed among the five functions involved in weather operations.

TABLE 3.6
AGENCY PERSONNEL ENGAGED IN WEATHER OPERATIONS, BY FUNCTION

AGENCY	Observations		Analyses and Forecasts		Communications		Dissemination to Users		General Agency Support		Total	
	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82	FY81	FY82
Commerce	1,390	1,336	1,813	1,697	133	133	978	912	1,368	1,366	5,682	5,444
	* 14	14	179	179	-	-	-	-	31	31	224	224
Defense	2,456	2,427	1,709	1,722	836	854	2,467	2,470	1,990	1,990	9,458	9,463
	** -	-	20	18	1	1	3	3	2	2	26	24
Transportation/ US Coast Guard	*** 36	35	-	-	18	18	4	4	47	52	105	109
Transportation/ FAA	617	587	-	-	997	973	1,228	1,206	582	619	3,424	3,385
EPA	-	-	13	13	-	-	-	-	-	-	13	13
NASA	*** 1	1	10	13	1	1	1	1	7	8	20	24
TOTAL	4,514	4,400	3,744	3,642	1,986	1,980	4,681	1,980	4,027	4,068	18,952	18,686

* Personnel funded by other agencies.
** Staff-years funded by other agencies
***Staff-years

Overall, agency staff resources for FY 1982 total 18,686. This is a decrease of 266 from the reported FY 1981 data. However, the FY 1981 estimate reported in last year's Federal Plan was 18,551 versus 18,952 reported this year. The difference of 401 is due to a change in accounting procedures within the Federal Aviation Administration and the Department of Defense.

Among the functions, "Dissemination" requires approximately 25 percent of all staff resources. This reflects the large number of field offices operated by the Departments of Commerce, Defense and Transportation, with many of these offices operating around-the-clock to serve the general public, military needs and the aviation industry.

The functions of "Observations" requires about 23 percent and "General Agency Support" accounts for about 22 percent of the staff resources for weather operations. Both are labor-intensive, particularly maintenance of increasingly sophisticated equipment and around-the-clock observations for forecasts, warnings, and aircraft operations.

"Analyses and Forecasts" consume approximately 19 percent of the Federal staff resources for weather operations. This function, while requiring a substantial number of personnel, makes extensive use of computers and related automated processing systems to prepare a wide array of products employed by field offices to satisfy the needs of the public and specialized users of weather information. A significant portion of these staff resources are devoted to preparing and maintaining the computer programs necessary to produce new, more effective products.

The "Communications" function requires about 11 percent of the staff resources, the smallest percentage of any of the functions. This reflects the fact that communication has become less labor-intensive over the years as modern equipment came into use. It is important to note that the high percentage of the total Department of Transportation (Federal Aviation Administration) staff resources devoted to "Communications" is attributable to operations of major communications systems which support the other agencies as well as the FAA.

INTERAGENCY FUND TRANSFERS

Federal agencies transfer funds to other agencies to pay for services that the receiving agencies can perform more efficiently and effectively. Table 3.7 shows the interagency fund transfers for FY 1981. The totaled net amount transferred is $66.3 million for operations and $4.5 million for research support. While specific amounts may vary from year-to-year, depending upon agency needs, the pattern shown in this table is essentially stable.

Department of Commerce

The Department of Defense will be reimbursed $4.3 million for costs of providing airborne weather reconnaissance of tropical cyclones and winter storms.

The National Aeronautics and Space Administration will be reimbursed $44.4 million for costs related to procurement and launch of NOAA operational spacecraft.

Department of Defense

The Department of Commerce will be reimbursed a total of $1.7 million for data acquisition and archiving and support of the Office of the Federal Coordinator for Meteorology under the provisions of OMB Circular A-62.

Department of Energy

Reimbursable costs estimated at $2.0 million will accrue to the Department of Commerce, principally for weather support services at the Nevada Test Site and at other National Laboratories.

Department of Transportation

The Department of Commerce will be reimbursed $14.6 million principally for meteorological support at Center Weather Support Units located with most Air Route Traffic Control Centers, research and development on meteorological equipment and prediction technology to support flight safety, and for support of the Office of the Federal Coordinator for Meteorology.

National Aeronautics and Space Administration

The Department of Defense will be reimbursed $294 thousand principally for meteorological support to the space-shuttle operations.

Environmental Protection Agency

Research and development support related primarily to air quality standards will require transfer of $2.8 million to the Department of Commerce.

Federal Emergency Management Agency

The Department of Commerce will be reimbursed $81 thousand for weather support services at the FEMA Special Facility.

LOCATIONS BY OBSERVING TYPE

Table 3.8 illustrates the large number of weather observing operations carried on by Federal agencies. Included for the first time in this Plan are the locations of Commerce's data buoy locations: Atlantic Ocean (5); Gulf of Mexico (5); Great Lakes (5); and Pacific Ocean (7). In FY 1982, three more buoys will be added in the Great Lakes and an additional one in the Pacific Ocean. The status and capability of data buoys can be obtained from the Director, NOAA Data Buoy Office, NSTL Station, MS 39529.

TABLE 3.7
INTERAGENCY FUND TRANSFERS FOR METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH, FY 1981
(Thousands of Dollars)

Agency		FY81 Funds	
Transferred from:	Transferred to:	Operations	Research
Commerce	DOD	4,257	-
	NASA	44,243	167
	State	78	-
Defense	DOC	1,650	-
	DOE	100	-
	NASA	30	-
	NSF		100
Energy	DOC	2,028	-
Transportation/FAA	DOC	13,363	1,200
	DOD	-	80
NASA	DOC	221	85
	DOD	294	-
	NSF	-	50
EPA	DOC	-	2,800
FEMA	DOC	81	-
TOTAL		66,345	4,482

TABLE 3.8
LOCATIONS BY OBSERVATION FUNCTION,
FISCAL YEARS 1981 and 1982

Observation Function	Agency	FY 1981	FY 1982
Surface (Land)	Commerce	404	404
	Commerce (Automatic)[1/]	140	140
	Defense (U.S.)	148	148
	Defense (Overseas)	87	87
	Transportation/FAA	383	383
	Transportation/Coast Guard	147	141
Surface (Marine)	Commerce (MSCP)[2/]	2,000	2,000
	Commerce (Data Buoys)	20	24
	Transportation (CG Ships)[3/]	197	197
	Defense (Ships w/Met Personnel)	32	32
Upper Air (Rocket)	NASA	1	1
	Defense (U.S.)	4	4
	Defense (Overseas)	3	3
Upper Air (Balloon)	Commerce (U.S.)	88	88
	Commerce (Overseas)	46	46
	Defense (Fixed - U.S.)	8	8
	Defense (Fixed - Overseas)	9	9
	Defense (Ships)[4/]	35	35
	Defense (Mobile)	13	13
	Transportation (Coast Guard)[5/]	19	19
Weather Radar	Commerce (U.S.)	123	123
	Defense (U.S.)	74	74
	Defense (Overseas)	18	18
Weather Reconnaissance	Defense (No. of Aircraft)	20	20

[1/] At 38 locations, winds only

[2/] MSCP = Merchant Ships Cooperative Program

[3/] At 60 locations, winds only

[4/] Equipped, but are not continuously operated

[5/] Balloon support facilities inactive but available for use

SECTION 4

NATIONAL CLIMATE PROGRAM

The National Climate Program was established in 1978 by Public Law 95-367 as a means to assist the country and the world "to understand and respond to natural and man-induced climate processes and their implications". The program, one of research and applications, requires coordinated efforts among the many agencies that develop climate understanding and knowledge, that use climate information in accomplishing their particular mission, and that are responsible for the active dissemination of climate information to promote its utility to Government industry and the public.

P.L. 95-367 requires a Five Year Plan to "establish the goals and priorities for the program" and provide details on agencies roles, funding requirements and expected program achievements. The Five Year Plan has been prepared by the National Climate Program Office (NCPO). It was promulgated by the President and received by the Congress on November 13, 1980. The Plan is intended as a guide (1) for Federal agencies, as they develop and manage their specific, mission programs; (2) for the research community, as the context for their studies; (3) for the private sector meteorologists and climatologists, as the source of information on Government activities that affect the availability of climate data and information products; (4) for Congress, as it exercises its oversight, authorizing and appropriating functions; and (5) for state and local governments, as they coordinate their own activities.

The National Climate Program totals $143.9 million for FY 1981. Four agencies--USDA, DOC(NOAA), NASA, and NSF--account for three-fourths of the total. The greatest strength of the present program is in research, where extensive international collaborative efforts have supplemented active programs in many Federal laboratories and academic institutions. Important satellite experiments are being funded to support further aspects of this research. Program activities in assessing the impacts of climate are also receiving additional attention in the present fiscal year. This is particularly true in the Departments of Agriculture and Energy.

The strategy that has been adopted for the National Climate Program is to emphasize early production of useful outputs on the basis of our research knowledge of climate while simultaneously expanding the understanding of climate and its relationship to society. This strategy is consistent with the purposes of the National Climate Program Act. It is the basis for the selection of particular emphasis and priorities for the program.

The Plan defines three important areas where special emphasis will be given over the next five years. These areas are:

- Providing climate products.
- Responding to impacts and policy implications of climate.
- Understanding climate.

Within each area two levels of priority activities are described. The highest priorities are the principal thrusts of the program, each a multidisciplinary, multiagency effort for which a lead agency has been designated. Areas of Program Concern, the second level of priority, are additional efforts that warrant attention during this planning cycle.

The Plan also includes a description of the full range of climate program activities for which continued support is necessary to meet future contingencies. The attention given to the priority efforts does not imply neglect of the continuing basic program.

The National Climate Program will be led and coordinated by the National Climate Program Office with the help and guidance of the Climate Program Advisory Committee, which has been established by the Secretary of Commerce, and other outside advisory groups. The office will work closely with the several agencies and the Office of Management and Budget in preparing and analyzing specific budget proposals to implement the Plan.

PROVIDING CLIMATE PRODUCTS

Principal Thrusts

Generation and Dissemination of Climate Information. This effort, with NOAA as the lead agency, is designed to accelerate the flow of useful information to users. Obstacles that have impeded the availability of data and its flow in the past are to be removed. New institutional arrangements among users, state climate offices, Federal agencies, and independent climate experts are to be established so that the full value of climate information can be realized. A necessary first step is the evaluation of the required structures for these institutional arrangements.

Climate Prediction. This effort includes the development, testing and implementation of techniques for improved monthly, seasonal and interannual predictions. The lead agency is NOAA, with major developmental participation by the non-Federal sector through the establishment of experimental climate forecast groups. Over the next five years, modest improvements in the skill of climate forecasts appear possible. There are now a number of well-conceived approaches which warrant further development and careful testing and evaluation.

Areas of Program Concern

In this category are Global Precipitation and Surface Climate Data Networks. The first one includes studies that could lead to better estimates of global amounts and locations of precipitation. The second is concerned with assuring the adequacy of the observational networks throughout the country that are used to collect the data for regional studies of climate and its impacts.

FY 1980 Achievements

1. Generation and Dissemination of Climate Information. NOAA, with input from other Federal agencies and members of the climate community, developed and published an Interim Climate Data Inventory (ICDI). This catalogue of climate data contains descriptions of some 650 climate and climate-related data sets

along with information on how to obtain the data. The ICDI is available on computer compatible magnetic tape and will serve as a basis for an international inventory to be developed under the auspices of the World Meteorological Organization. The ICDI has been a long-sought objective. The current effort grew out of a Workshop jointly sponsored by the NCPO and NOAA/EDIS and held in May 1979.

In addition, NOAA has:

- Established priorities for developing improved access to high-demand data sets.
- Formulated an interagency subgroup for coordination on the Generation and Dissemination Principal Thrust.
- Completed a survey of prior data user workshops to compile recommendations, determine their status, and plan future programs.

2. Climate Prediction. The NOAA Climate Analysis Center (CAC) placed high priority on the development and expansion of an effective data base from which to provide climate information and to support extramural researchers. The CAC has completed the design and begun operation of a climate diagnostic data base which contains 15-day mean and other statistical measures from operational data compiled by NMC and NESS. The CAC has also formulated a set of simple climate indices for monitoring the strength of the 200 mb flow, sea surface temperature, and large-scale precipitation variations in the tropical Pacific.

In the area of climate prediction, there were several results that promise the development of useful predictive relationships associated with the "southern oscillation", a large-scale oscillation in the entire expanse of the tropical Pacific. There is evidence that it may be possible to predict, perhaps a season in advance, abnormally cold winters in North America (such as 1976-77) which are associated with warm sea surface temperature anomalies in the Pacific. While conclusions must be tentative, it now appears that this area will continue to be of significant research interest because of the prospect of useful long-term predictions.

IMPACTS AND POLICY IMPLICATIONS OF CLIMATE

Principal Thrusts

CO_2, Environment and Society. Atmospheric carbon dioxide is inexorably increasing and there is a scientific consensus that the increase will continue and will cause climate changes. There is great urgency to learn when these effects will occur and what they will be, but even more important is assessing the potential social and economic consequences. Because the increase of CO_2 is associated primarily with the burning of fossil fuels, this principal thrust is under the leadership of the Department of Energy. This thrust includes studies to determine the nature, strengths, and locations of the climatic effects. Investigations of physical and chemical systems to understand the rate at which these changes will occur, and studies of the impacts of these changes on the environment and on our societal system. At the end of the five-year period covered by the Plan, a major assessment of the state-of-knowledge and the policy options available for future planning will be completed.

Climate and World Food Production. The Department of Agriculture will lead an effort to understand the impact of climate variations on world food production, and how to utilize that information to make better decisions on production, trade, management, and allocation. Climate information will be incorporated into analyses and forecasts involving livestock and fisheries production so that decisions on food and agricultural policy can be made to stabilize world food stocks and supplies.

Areas of Program Concern

In addition to the above principal thrusts on climate impact, the Climate Program is concerned with:

- Societal impacts, responses, and processes in connection with climate-related natural hazards.
- Quantitative impact of climate on the demand, production, and distribution of energy.
- Development of impact assessment methods to support decision-making at the national policy level.
- Physical and chemical processes resulting from industrial or societal activities that could lead to regional climate changes.
- Impact of climate fluctuations on the productivity of arid and semi-arid land.
- Availability of climate data and information needed for management of water resources and related planning.

FY 1980 Achievements

CO_2, Environment and Society. Through research and integrative workshops associated with the National CO_2 Program, we are gaining greater knowledge of the global carbon cycle and the long-term history of atmospheric CO_2. For instance, estimates based on glacial core samples and ocean sediment samples indicate that during the last ice age CO_2 levels were about half the current level. Work is continuing to define more precisely the role the oceans play in the global carbon cycle. This is the key to estimating what future levels of atmospheric CO_2 will be. There are also continuing studies of refined and global transient climatic responses to increasing CO_2 and the oceans' role in delaying those responses.

UNDERSTANDING CLIMATE

Principal Thrusts

Solar and Earth Radiation. This effort, led by NASA, is designed to elucidate the processes by which the climate system gains and loses energy. Our knowledge of the stability of the climate's solar energy source, and our understanding of the varying means by which the Earth distributes energy and emits it back to space will be advanced substantially over the next five years. The simultaneous observations of the different components of this radiative exchange will lead to improvements in our knowledge of the relationships between solar variations and climate fluctuations.

Ocean Heat Transport and Storage. This thrust, led by NSF, signals the start of a major, coordinated international effort designed to increase our understanding of the ocean's role in climate. The oceans redistribute energy within the climate system, and exercise a large measure of control over the behavior of the entire system. During the five years covered by the Plan, there will be major advances in learning how to make large-scale measurements of ocean currents and temperatures, and understanding of ocean-heat transport and storage. This is an activity that is attracting considerable international scientific interest. A series of major international experiments are likely to evolve in the latter half of this and the next decade.

Areas of Program Concern

In addition to the above principal thrusts to understand climate processes, the Climate Program is concerned with:

- Studies of large-scale interactions between to major components of the climate system such as air/sea interactions.
- Development of improved climate models.
- Methods to study climate regimes not recorded by the limited instrumental record.
- The role of the Arctic regions as a cause and as an ndicator of climate change.
- Research on stratospheric chemical and physical processes to detect climatically significant changes such as ozone depletion.

FY 1980 Achievements

Solar and Earth Radiation. NASA, in conjunction with the principal thrust on solar and earth radiation, has been continually gaining more precise and conclusive evidence on the variability of the solar flux--still referred to as

the "solar constant". Detailed planning is now well underway on the Earth Radiation Budget Experiment. The aim of the experiment is to measure the variations in the partition of solar radiative energy among the components of the radiation budget and then to relate those variations to climatic variability.

INTERNATIONAL AND NATIONAL ACTIVITIES, FORECAST CENTERS

In addition to a description of the scope of activities that comprise the climate program and a detailing of the priority efforts required for progress, three "special aspects" are discussed in the Plan.

International Activities

International cooperation in climate-related matters is a cornerstone for the National Climate Program. Cooperation is essential in collecting and disseminating data, in undertaking research, and in assessing climate impacts. The United States cannot manage these efforts alone. The World Climate Program, consisting of subprograms in research, impact studies, data, and applications, is the major vehicle for such cooperation. Many international bodies have joined in this effort, including the United Nations Environment Program, the International Council of Scientific Unions, and the World Meteorological Organization.

A number of specific activities are presented in the Plan which the U.S. National Climate Program will contribute to the World Climate Program. These activities involve ocean research, climate prediction, international concern for CO_2, assistance to developing countries in applied climatology, and others. The U.S. will also engage in bilateral climate cooperation that is consistent with the goals and programs of the World Climate Program.

Intergovernmental Climate Program

The National Climate Program Act directs the establishment of a program for Federal and State cooperative activities in climate. The Plan outlines a phased development of this program as an integral part of the principal thrust in the generation and dissemination of climate information. The functions of the cooperative efforts emphasize the availability and use of local and regional climate information. The first exploratory efforts, to gain the knowledge for the design of the intergovernmental program and demonstrate its worth, began in FY 1980. These pilot studies will also lead to decisions on appropriate cost-sharing and allocation of functions between the Federal Government and the states. The full implementation of the program will depend on the outcome of these studies.

Experimental Climate Forecast Center

The National Climate Program Act requires that the program include "experimental climate forecast centers . . . ". The purpose of the centers (to be established at non-Federal institutions) is the development and testing of innovative approaches to long-range prediction and early recognition of useful

prediction capability. The program will emphasize forecast verification. The Climate Analysis Center will then adopt for testing under operational conditions, those experimental techniques found to have merit.

FY 1980 Achievements

1. The World Climate Program. The World Meteorological Organization (WMO) has structured the World Climate Program (WCP) into four categories of effort: the World Climate Research Program; the World Climate Data Program; the World Climate Applications Program; and the World Climate Impact Studies Program. The Director of the U.S. National Climate Program has formulated a compatible structure to facilitate U.S. involvement in planning for the WCP. Coordinators have been appointed for U.S. planning in each of the categories as follows:

- o World Climate Research Program: Director, Special Research Programs Office, NOAA

- o World Climate Data and Applications Programs: Director, Environmental Data and Information Services, NOAA

- o World Climate Impact Studies Program: Climate Program Coordinator, Department of State.

2. The State-Federal Cooperative Demonstration Studies. NCPO funded the first set of cooperative demonstration studies of the development and local delivery of climate services. The NCPO solicited proposals, formed an interagency team to evaluate the proposals, and awarded five study grants that totaled $105,000. The grants were as follows:

- o Colorado State University: Colorado Demonstration, Intergovernmental Climate Program

- o Michigan State University: Design and Evaluation of the Feasibility and Benefits of a Regional Intergovernmental Climate Program

- o San Diego Gas and Electric Company: Public Utility Participation in the Intergovernmental Climate Program

- o Connecticut Department of Environmental Protection and the University of Connecticut: The Initiation of a State Climate Program with Cooperating State Natural Resources and Education Agencies in Connecticut

- o University of Oklahoma: Statewide Dissemination of Climatological Information via Educational Television.

An interagency group, similar to the group which evaluated proposals, will aid the NCPO in oversight and evaluation of the grants. A program development plan is being drafted which will describe the process for proceeding from this demonstration phase to latter phases of the Intergovernmental Climate Program.

3. Experimental Climate Forecast Centers. During FY 1980, the NCPO solicited proposals to establish the first center. Thirteen proposals were received from prestigious research institutions around the country. An interagency group of experts evaluated the proposals and a grant to establish the first center is being awarded to the Scripps Institute of Oceanography, La Jolla, California. The establishment of additional experimental groups is an option for future program development. Groups will be selected with a view to their potential for developing innovative approaches to prediction, including predictions for particular applications of climate information like energy or agriculture. The experimental forecast centers will also be involved in research on how to improve verifications of climate predictions.

APPENDIX A

SUMMARY OF INTERAGENCY COOPERATION
OUTSIDE OMB CIRCULAR A-62*

AGENCIES	PROGRAM
Department of Commerce (DOC) and Department of Defense (DOD)	o DOC: - Provides data support to the U.S. Navy climate program; - Shares the National Climatic Center computer facility with the U. S. Air Force; - Provides climatic support to the Corps of Engineers Alaska district; - Archives Defense Radio Solar Telescope Network data; - Participates in mutual exchange of products and services related to solar observing optical network data; - Provides joint operation for a centralized Space Environment Support Operation (SESO). o DOD provides sea-ice forecasts to DOC.
DOC and the National Aeronautics and Space Administration (NASA)	o DOC: - Provides consultation services and real-time operational meteorological support to NASA's L. B. Johnson Space Center and Marshall Space Flight Center; - Provides joint technical and support services at Mississippi test facility, Bay St. Louis, MS. o NASA provides: - Joint technical and support services at Wallops Island.

*Cooperation between agencies in which DOC is not a party was not reported for this table.

DOC and Department of Energy (DOE)

- o DOE provides support for:
  - Development of energy demand models;
  - National strategic petroleum reserve environmental analyses;
  - Ocean thermal electric conversion data;
  - Production of geothermal maps;
  - Research on atmospheric plume dispersion in complex terrain and studies of the micro-climate in a deciduous forest;
  - Measurement, quality control, and archiving and publication of solar radiation from a DOC solar radiation network.
- o DOC provides technical support for the Nuclear Test Site, Nevada.

DOC and the National Science Foundation (NSF)

- o DOC edits, processes and archives International Decade of Exploration (IDOE) data;
- o DOC performs joint services for the National Center for Atmospheric Research.

DOC and the Federal Emergency Management Agency (FEMA)

- o DOC provides:
  - Meteorological services, predictions, and coordination to support responses to natural hazards associated with severe weather;
  - Hurricane films and public service announcements;
  - Fallout forecasts and other technical assistance in event of nuclear attack alert.

DOC and Environmental Protection Agency (EPA)

- o EPA provides:
  - Research on urban air pollution;
  - Research on acid rain and aerosols;

- Monitoring and research in the measurement and interpretation of solar ultraviolet radiation;

- Research and monitoring support for long-range effects of ocean pollution.

DOC and the U.S. Department of Agriculture (USDA)

o DOC:

- Publishes the weekly Weather Crop Bulletin;

- Maintains a soil moisture network;

- Jointly staffs Agricultural Weather Facility;

- Provides warnings on natural disasters.

APPENDIX B

COMPILATON OF STATEMENTS ON WEATHER PROGRAMS SUBMITTED TO THE OFFICE OF THE FEDERAL COORDINATOR BY THE AGENCIES

DEPARTMENT OF AGRICULTURE

The nation's food and forest resources are becoming increasingly important to our domestic and international economic situation. Food has recently taken on new dimensions in foreign affairs and national security. Weather and its effect on crop yields is one of the most important factors in the Nation's agricultural production. The USDA conducts supporting research that focuses on understanding the interactions of weather and climate with plants and animals. USDA also assists the Department of Commerce in determining farmers' needs for weather information and in disseminating such information to them. The Nation's forest resource must be managed for multiple use and must be protected from adverse impacts of fire, insects, disease, and pollution.

USDA conducts research that focuses on better management of the forest resource and the role weather plays in achieving those goals pursuant to its mission. USDA takes special fire weather observations and cooperates with the National Weather Service in providing fire and land management weather information to help manage the almost 181 million acres of national forest land.

The mission of the supporting research is to develop and disseminate information and techniques to insure an abundance of high-quality agricultural commodities and products, while minimizing any adverse effects of agriculture on the environment. The Science and Education Administration's (SEA) research efforts relate directly to climatic effects and deal with developing technology and systems such as: 1) to manage precipitation and solar energy for optimum crop production; 2) to understand and manage water resources for agricultural use; 3) to understand the water-plant-atmosphere interactions; 4) to optimize the use of energy, water, and fertilizer; 5) to reduce plant and livestock losses from pests; 6) to improve techniques for irrigation and drainage; 7) to reduce plant and livestock stress from the environment; 8) to develop production, management, decision, and tactical models and systems to minimize the adverse effects of climate and weather; 9) to model the exchange between the atmosphere and gaseous compounds; and 10) to develop climate-related phenological crop models for the Great Plains.

Studies are being performed to determine the action of air pollutants on plants and methods of controlling the damage. SEA is cooperating with State and Federal agencies and universities to establish a nationwide program for monitoring deposits of atmospheric pollutants to determine their extent and effects on agriculture and natural ecosystems.

The Forest Service is continuing its program of meteorological supporting research, with emphasis on weather effects on forest fires and air quality. Research is pointed toward supporting Federal and other land managers by providing information on fire and smoke management, for prevention of significant

deterioration of air quality and related values by studying the mechanisms by which mountainous terrain affects meteorological conditions. This includes the replacement of manually-operated stations with 60 remote automated weather stations.

Investigations carried out by the Economics and Statistics Service (ESS) will determine the potential economic effects of weather in crop production, both domestic and foreign. One aspect of these studies is the development of models relating various weather parameters to crop yields. Econometric and simulation models of weather-crop-yield interactions, together with other variables affecting crop yields, are constructed for use in economic analysis, including short-run forecasting and long-range projections.

DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

The National Oceanic and Atmospheric Administration (NOAA) is the principal meteorological agency of the Federal Government. By law, NOAA is responsible for reporting the weather of the United States and providing weather and flood forecasts and warnings to the general public, developing and furnishing specialized weather service for specific user groups, and recording the climate of the United States. This mission is carried out within NOAA by the National Weather Service (NWS), the National Earth Satellite Service (NESS), the Environmental Research Laboratories (ERL), and the Environmental Data and Information Service (EDIS). DOC is charged by statutory authority to prepare an annual plan presenting a horizontal view of meteorology to be submitted with the President's budget. This requirement has been implemented by OMB Circular A-62, and a DOC implementation plan establishing within DOC the Office of the Federal Coordinator for Meteorological Services and Supporting Research.

NATIONAL WEATHER SERVICE

INTRODUCTION

This section describes the National Weather Service's (NWS) purposes, mission, and major products and services, together with the system used to develop these products and services and to make them available to users. It shows NWS's major functions, the sequence in which they are performed, and the principal performing organization within NWS. It also shows the resources NWS devoted to these functions and the ways in which NWS measures their principal outputs.

MISSION

Basic purposes of the NWS are:

- To help ensure the safety and welfare of the general public with respect to weather conditions, including conditions involving natural disasters.

- To further the conduct of governmental, commercial, industrial and other activities which are affected by the weather, such as agriculture, forestry, marine and fishing, aviation, transportation, construction, and energy transfer.

To fulfill these purposes, NWS:

- Observes and reports the weather and the river and ocean conditions of the United States and its possessions.

- Issues forecasts and warnings of weather, flood and ocean conditions.

- Develops national meteorological, hydrologic, and oceanic service systems.

- Performs applied meteorological research.

- Assists in developing community preparedness programs for weather-related natural disasters.

- Participates in international meteorological activities, including exchange of data and forecasts.

BASIC ENABLING LEGISLATION AND AUTHORITY

- Organic Act of 1890 created the U. S. Weather Bureau.

- Enabling Act of 1919 allowed U. S. Weather Bureau to enter into cooperative agreements for providing agriculture weather services.

- Flood Control Act of 1938 authorized the establishment, operation, and maintenance of the Hydroclimatic Network by the Weather Bureau for Flood Control.

- Federal Aviation Act of 1958 outlined duties of the Secretary of Commerce for provision of weather observations and services to aviation.

- OMB Circular A-62 established criteria for Federal provision of meteorological services and supporting research.

PRODUCTS AND SERVICES

NWS produces two general kinds of products and services:

- Weather observations, forecasts and warnings, both scheduled and unscheduled, and consisting primarily of descriptions of current weather, climate, river and sea conditions, and predictions of future weather and climate events and conditions.

- Technical, advisory, and other ancillary meteorological and hydrological services.

Weather observations, forecasts, and warnings include:

- General weather conditions, including sky conditions, temperature, wind, precipitation, visibility, pressure, tides and currents, and solar radiation.

- Severe weather events such as hurricanes, other tropical storms, tornadoes, thunderstorms, and severe winter storms.

- Hydrologic conditions, including river levels, flood levels, and flash floods.

Preparation of 30-Day and Seasonal Outlooks

The 30-day weather outlook for the U.S. is issued twice monthly by the National Weather Service; it gives the expected temperature (above, near, or below normal) and the expected precipitation (above or below the median). The seasonal or 90-day temperature outlook is issued at the end of each month; the seasonal precipitation outlook is included for the winter and summer seasons.

- Marine weather, including coastal tides and currents, hazards to navigation on the high seas, conditions for pleasure boating, and ice and other factors affecting marine navigation.

- Tsunamis affecting the west coast of the United States, including Alaska, Hawaii, and United States territories in the Pacific.

- Aviation weather, including terminal and enroute weather advisories principally detailing type of precipitation, cloud ceilings and visibility, wind factors, and such significant enroute aviation hazards as aircraft icing, turbulence and thunderstorms.

- Agricultural weather, including soil moisture and temperature, leaf wetness, evaporation, drying conditions, and other factors affecting farming and ranching.

- Fire weather, including fuel moisture and meteorological conditions affecting wildfire control, and forest and rangeland management operations.

- Environmental quality, including meteorological conditions affecting smoke and air quality management operations.

- Weather conditions affecting such special activities as space flight operations, radiological emergencies, controlled burning to remove forest wastes, and oil spills and other emergencies affected by the weather.

Dissemination of NWS's weather reports is accomplished principally through electronic means: radio, TV, telephone, teletypewriter circuits, and facsimile. However, some are through face-to-face contact or visual inspection of products by the using community. Four principal kinds of electronic systems used are:

- Systems involving the mass news media: radio, television, and the newspaper. These outlets are linked to the NWS primarily by teletypewriter circuits.

- Those involving other Government agencies, primarily the Federal Aviation Administration (FAA) but also other Federal, state and local agencies.

- Those involving heavy-duty telephone answering devices operated by telephone companies.

- The NOAA Weather Radio (NWR) System which provides continuous, direct access to the using community. In 1981, 350 stations nationwide were on the air.

- U.S. Coast Guard and commercial CW radio, radio teletype, and satellite terminals to the ships at sea.

NWS also performs a variety of other services, including:

- Disaster preparedness services.
- Technical services for agriculture.
- Assistance through the Voluntary Co-operation Program of the World Meteorological Organization (WMO).
- International meteorological and hydrologic advice and consultations.
- Climatological services.
- Litigation and expert testimony activities.

BASIC FUNCTIONS

NWS carries out four broad functions that are basic to the development and dissemination of its principal product group, which are weather reports. These are:

- Data acquisition
- Forecast and warning preparation
- Communications
- Applied research and development relating to the above.

Data acquisition involves observation, collection, and some preprocessing of data on atmospheric, hydrologic, and oceanic conditions. Atmospheric data are by far the most important, accounting for more than 90 percent of the data acquisition budget and are further subdivided by type of observation:

- Surface
- Upper air
- Radar
- Aircraft

Forecast preparation includes data processing and analysis, as well as development of predictive material. The function is subdivided by the scale and focus of this material:

- Large-scale forecasting focuses on national and hemispheric weather and mostly produces guidance material for other forecasting.
- Specialized forecasting areas which are determined by the nature of the specific conditions and the events being predicted and produces both guidance material and products intended for the user.

- Small-scale forecasting focuses on areas such as counties, cities, communities, harbors and lakes, forests, and other individual localities. It is often an adaptation of the medium scale products.

The communications function divides into subfunctions:

- Internal communications involve the transfer and distribution of information within the meteorological community (i.e., communications between data acquisition points and forecast preparation centers and between preparation centers). This community includes NWS, other Federal agencies (such as FAA, Coast Guard, and the Department of Defense), the international meteorological organizations, and the private practitioners.

- External communications involve transmission of weather and river information to the public and specialized users. It involves the systems described in the preceding section: the media, FAA, and other Government agencies, commercial telephone systems, commercial marine broadcast systems, and the NWS radio transmission system.

The functions above are carried out by the following principal organizational components:

- The National Meteorological Center (NMC) in Camp Springs, MD, makes large-scale forecasts and develops associated guidance material.

- The National Hurricane Center (NHC) in Miami, FL, and two regional centers in San Francisco, CA, and Honolulu, HI, are concerned with specialized forecasts and associated guidance for hurricanes and tropical storms.

- The National Severe Storms Forecast Center (NSSFC) in Kansas City, MO, is concerned with specialized forecasts and guidance for tornadoes and severe thunderstorms. NSSFC also provides aviation forecasts and advisories concerning severe convective activity.

- The 13 River Forecast Centers (RFCs) produce specialized river and flood level forecasts and guidance material. Each RFC covers a major national watershed or portion thereof involving several states.

- The 52 Weather Service Forecast Offices (WSFOs) prepare and issue medium- and small-scale forecasts and weather watches and warnings, and acquire meteorological data. There is essentially one WSFO per State.

- The 199 local Weather Service Offices (WSOs) issue small-scale forecasts and weather watches and warnings, and acquire meteorological data.

- There are 39 Weather Service Meteorological Offices (WMSOs), 11 Weather Service Contract Meteorological Offices (WSCMOs), and some 600 automated observing stations that acquire data.

- There are 54 of the 251 WSOs/WSFOs with designated Hydrologic Service Area responsibility that provide public hydrologic services.

The functions described above are performed in a sequence which, though occasionally modified, establishes the essential of NWS's product flow. This sequence basically involves:

- o Data acquisition.
- o Use of selected data to prepare large-scale forecasts.
- o Use of selected data and large-scale forecasts to prepare specialized and medium-scale forecasts.
- o Release of these forecasts to the user, either with or without further adaption to reflect small-scale conditions.

DATA ACQUISITION

The product sequence begins with the acquisition of data on atmospheric, hydrological, and oceanographic conditions for the United States and large portions of the rest of the world. Most of the data are collected by the NWS, FAA, NESS, the Department of Defense, weather services of other nations, and cooperative observers (the latter including both land, oil platform, and shipborne cooperative observers). Some of the data also come from the Soil Conservation Service, the Forest Service, and the Geological Survey.

There are more than 1,000 principal surface observation points nationwide, with about 400 sites providing 24-hour service. Schedules at other sites are predicated on established needs, e.g., flight schedules. Most NWS observations are manually acquired by the WSFOs, WSOs, WSMOs, and WSCMOs, although NWS is in the process of automating selected sites through its automated meteorological observing system. Elements observed include cloud cover, temperature, dew point, wind speed and direction, atmospheric pressure, and precipitation type and amount. These principal sites are augmented by 12,000 land-based cooperative observers, who report daily temperature and precipitation amounts.

Many of these field stations also send balloon-borne meteorological instruments aloft to measure temperature, moisture, pressure, and wind to 29 km above the surface. A few rocket soundings reach 100 km. There are 140 observation sites within the United States and its territories, the Caribbean, Mexico, and Central and South America. Most sites take two upper-air soundings per day at the standard analysis times of 1200 GMT and 0000 GMT. These soundings are augmented by weather observations from aircraft in flight.

Specifically designed NWS weather radars monitor the location, extent, intensity, and movement of such severe or hazardous weather conditions as hurricanes, tornadoes, severe thunderstorms, and intense winter snowstorms. Weather radars also are capable of qualitative estimates of rainfall amount over specific watersheds, which aid the forecasting of river floods and flash floods. About 123 weather radars are operated by WSFOs, WSOs, and WSMOs. These are augmented by about 90 weather radars operated by the Department of Defense. Of the NWS radars, 56 are staffed and operated continuously. NWS also makes observations from 22 FAA air traffic control radars in the mountainous regions of the west.

Polar-orbiting and geostationary environmental satellites collect large volumes of weather data in the visual and infrared spectrums by radiometry. NESS operated weather satellites "see" cloud cover, profile vertical temperature and humidity fields (soundings), measure sea surface temperature, portray sea ice coverage, and provide data from which frost conditions, cloud tops, and high altitude wind fields can be derived. They also collect and relay environmental data observed by fixed and moving remotely located sensing equipment.

Hydrologic data are collected at about 8,000 river points nationwide. Data measurements are made of river levels and precipitation amounts as input to prediction models that forecast river stages for 2,500 points. Some of these data are obtained automatically through NWS's Automated Hydrologic Observing System (AHOS).

NWS collects 90,000 to 95,000 marine surface weather observations monthly from cooperative weather observers aboard ships at sea worldwide. This is our international program participated in by 103 countries with a merchant marine. The U.S. Cooperative Ships Program is possibly the largest with over 2,000 ships in the program. There are 13 Port Meteorological Officers strategically located in U. S. ports to serve as liaison between NWS and the marine community.

Oceanographic data include "profiles" of deep ocean temperature and salinity, which are derived from bathythermographic measurements made by U.S. Department of Defense, U. S. research vessels and cooperating merchant marine ships. There are undersea measurements made at different depths. Sea-surface temperatures are observed and reported by NOAA data buoys, the U. S. Navy and American research vessels, as well as by ships-of-opportunity of many nations. Observations of tides, seá and swell are also observed and reported daily.

FORECAST PREPARATION

Once acquired, the data are transmitted to all NWS organizations that have pertinent forecasting responsibilities. The organizations then process and analyze the data and use the results to prepare their respective outputs. Such organizations include the WSFOs, and WSOs, as well as the large-scale and specialized weather forecasting organizations that have major responsibilities for preparing guidance material for the WSFOs and (through the WFSOs) for the WSOs.

Preeminent among these organizations is the National Meteorological Center (NMC), which in many respects is the key to NWS's analysis and forecast function. NMC has responsibility for developing coordinated large-scale forecasts and associated guidance material for the United States and much of the rest of the Northern Hemisphere, plus portions of the Southern Hemisphere. It produces a large number and variety of graphic products describing both current and forecast conditions throughout these areas.

Current condition depictions include 3-hourly and 6-hourly pressure analyses at the surface and 12-hourly analyses at about 1.5, 5.6, and 10.4 km above the surface. These products are produced by a mix of computerized numerical methods and human intervention to adjust for subjective considerations. They give forecasters throughout the Nation a generalized, three-dimensional analysis of the current weather conditions.

Using information on current conditions as a starting point, NMC then uses objective numerical weather prediction programs (based principally upon various models of atmospheric dynamics and Model Output Statistics - MOS) to predict future conditions of the Nation's weather for periods up to 10 days.

NMC transmits this entire body of information to forecasters throughout the Nation as guidance material for the preparation of specialized, medium-scale, and small-scale forecasts which become the final products issued to the using community. This information is distributed widely. NMC makes about 2,000 facsimile and teletypewriter transmissions daily to field forecasters. In addition, there are daily communications schedules for overseas users.

NMC's products are intended primarily to guide organizations responsible for specialized and medium-scale forecasts, and virtually all are made available to the public through these forecasts. A few products, however, are disseminated without change, either directly by NMC or through other NWS organizations.

Specialized forecasting covers a less-than-national area, either a variable area determined by the current and future condition of hurricanes, tornado systems, or other specific phenomena; or a fixed area determined by river and stream drainage. Forecasts of NSSFC and NHC fall into the first category; those of the RFCs into the second. All, however, share two common characteristics:

- They forecast only specific meteorological/hydrological phenomena.
- Their products represent important guidance to the WSFOs and influence WSFO forecasts, but they typically also go to some users without change.

NSSFC prepares and issues tornado and severe thunderstorm "watches", which are then disseminated to the public in the threatened areas. A watch is a public-oriented statement which indicates that meteorological conditions are favorable for the development of severe thunderstorms or tornadoes. The watch statement may include advice as to what precautions should be taken by the public to protect itself from these hazards. As opposed to a watch, a warning of severe thunderstorms or tornadoes can be issued by any NWS field facility when a thunderstorm or tornado has been sighted.

NHC issues bulletins describing the current and future location, intensity, and movement of hurricanes, other tropical storms, and associated coastal tides. These bulletins are considered final products and are issued either directly or through the WSFOs to the public and other interested groups without modification.

Just as NHC and NSSFC analyze and forecast hurricanes and other severe disturbances, the RFCs develop specialized analyses and forecasts of river levels and flood stages to be expected in major national watersheds. They also develop runoff and snowmelt forecasts. RFC forecasts are normally disseminated to the public through the WSFOs without change.

Building primarily upon the material provided by NMC, the 52 WSFOs reanalyze and develop a large number of forecast products particularized and stylized in terms of area peculiarities and special user needs. These medium-scale forecasts often are issued directly to the public without further modification. A representative list of these products follows:

- State forecasts cover general weather conditions out to five days for a State or, for areas like New England where the States are small, a grouping of States. Information would include expected amount of sunshine or cloudiness, precipitation, diurnal temperature variations and wind conditions.

- Zone forecasts are similar in content to state forecasts but further particularized to an area generally comprising several counties or parishes.

- Recreational forecasts are similar to zone forecasts, but limited to recreational zones, beaches and pleasure boating areas, skiing areas and so on.

- Agricultural forecasts reflect a further particularization of the weather elements included in a State forecast, to allow decision-making by farmers in terms of spraying crops, irrigating, harvesting and so on.

- Aviation forecasters again represent a further particularization of weather elements, so that the information applies to airport conditions and inflight weather.

- Marine forecasts focus on the coastal areas and high seas. They cover general weather conditions with specific emphasis on wind and wave conditions.

- Fire weather forecasts provide the weather elements for use in fire management planning, forest and rangeland management activities, and wildfire control. These specialized forecasts are often very localized, site - specific and time - specific in nature.

- Air pollution forecasts provide the necessary weather elements to express the atmosphere's ability to dilute and disperse pollutants as required for air quality management activities.

Small-scale forecasting involves the modification of medium-scale products so that they describe a specific locality, such as a city and its suburbs, an airport terminal, a national forest, a farming community, a local recreational area, a point-source polluting area, and space launch and recovery areas. This process considers two different sets of variables: (1) topographic and climatological peculiarities, and (2) unique parameterization of the basic weather elements to make them useful for specialized activities. Examples of the latter would be spraying information for crop protection or estimates of fuel moisture content of the debris covering a national forest.

Many small-scale public weather forecasts are made by meteorological technicians at the WSOs. These forecasts are frequently described as local adaptive forecasts as they are not original forecasts but rather an adaptation and localization of medium scale forecasts to meet local needs. Areas without a WSO, a locally situated WSFO, or NOAA Weather Radio coverage do not have access to such adaptive local forecasts and use the applicable medium scale forecasts instead.

COMMUNICATIONS

Transmission of data from points of observation to forecasting centers, between such centers and within the meteorological community generally is the job of NWS's internal communication systems. These systems involve landline telephone, radiotelephone and microwave transmission. They make use of teletypewriters, facsimile equipment, telephones and specialized computers. The computers are used to perform various processing operations that facilitate transmission, particularly transmission of data to forecasting centers.

Besides its own system, NWS has access to and uses a number of communication systems maintained by the FAA, the DOD, and other Government agencies. The FAA systems play a particularly important role, forming an integral part of the overall network. The U.S. Coast Guard maintains major radio stations for services to the mariner. They receive most of the marine weather messages and transmit marine forecasts and warnings to the ships at sea.

NWS uses three principal groups of internal communication systems:

- Longline teletypewriter systems that are controlled by FAA and which handle much of NWS's observation data and many of its public forecasts.
- NWS-controlled facsimile systems that are used for the transmission of forecast guidance material, as well as some data.
- A special NWS system reserved largely for radar data and hurricane, tornado and flash flood and other storm or flood warnings, and marine data.

External communications--the transmission of forecast information to users--are charcterized by systems which involve:

- Government-operated teletypewriter systems to commercial TV and radio stations, e.g., NOAA's Weather Wire Service.
- Direct radio broadcasts to the public through NOAA Weather Radio System.
- Heavy-duty automatic telephone answering devices which are operated by telephone companies and which directly give the public weather information furnished by NWS stations.
- Direct NWS-to-the-public telephones, including automatic answering devices at NWS field offices and personalized services.
- Government and other intermediaries, e.g., Coast Guard radio telephone, FAA weather information disseminating systems, civil defense systems such as the National Warning System (NAWAS) and systems run by private communication companies.

External communication is the principal effort to disseminate weather intelligence to the users--the public, industry, and other specialized groups. The success or failure of this effort depends almost totally on the cooperation among NWS, other Government agencies, and private industry, especially the mass news media. NWS is capable of transmitting this information in a timely manner

The Centralized Communication Facility of the NWS

This National Weather Service facility serves as a hub for approximately 60 low and 15 medium-speed communication links for receiving and transmitting meteorological data. The facility processes incoming data and provides data for the large-scale computers of the National Meteorological Center. It transmits the NMC forecast products to the National Weather Service's forecast offices, other Federal agencies, and to non-Government users. The facility is also part of the World Meteorological Organization's Global Telecommunications System and serves as the gateway for meteorological data exchange.

to the news media, but depends heavily on the news media for further transmission to the user. For this reason, NWS's current efforts are focused on the direct radio broadcasts described earlier. Examination of direct dissemination via public-service and cable television is also underway.

NWS views the present system for collecting, preparing and distributing weather information as too slow and cumbersome to permit optimum response to warning situations. It has been acceptable up to now, because the current system was limited by the state-of-the-art in communication technology. Now, the microprocessor has been adequately developed and NWS is proceeding to a new level of communication under AFOS (Automation of Field Operations and Services), which will shorten the time between the recognition of hazardous weather and the issuance of warnings to the general public from between five and 15 minutes to as short a time as a minute or two in most instances.

Through AFOS, weather offices will be provided with modern processing display and communication technology that will allow them to:

- o Automate the routine duties of professional personnel.
- o Provide automated assistance to the professional aspect of the forecasters' jobs.
- o Communicate data to the forecaster and information to the news media over the computer-controlled circuits.

When fully implemented, AFOS will either replace or require large modifications in present communication systems.

APPLIED RESEARCH AND DEVELOPMENT

To ensure that the quality of NWS forecasts and services continues to improve and is in line with current state-of-the-art, applied research and development is being carried on in a number of areas.

- o Numerical Prediction. Research and development is aimed at improving the day-to-day general forecasts and warnings and hurricane service by placing the analysis and prediction system on a stronger scientific basis. Numerical prediction models that simulate atmospheric and hydrologic processes are constantly worked on and better computer techniques to solve the underlying equations are developed. Long-range prediction research is aimed at developing improved forecast techniques, climatology and statistical analysis.
- o Forecasting Techniques Development. The design, development, test, and evaluation of improved objective forecasting techniques for operational use, and any required applied research activities. Special attention is focused on providing to field forecasters automated guidance forecasts of weather elements of immediate concern to the public and to users of specialized weather information such as the aviation and agricultural communities.
- o Short-term Climate Fluctuations. Research and development are aimed toward improving the accuracy, extent, information content and lead time

of seasonal outlooks. Diagnostic studies are being conducted of short-term regional and global climate fluctuations.

- o Hydrologic Models. Research efforts concentrate on the improvement of specific facets of the NWS River Forecast models using meteorological information and forecasts. Studies, augmented by research contracts, involve dam-break flood forecasting, snowmelt, mechanics of the rivers, data acquisition and analysis techniques, and procedures to update river forecasts.

- o Equipment Development. NWS conducts research to devise and develop new and improved techniques for measuring weather elements. Meteorological instrumentation is being developed with a primary emphasis on automating the detection and dissemination of the data. Integration of automatic sensing equipment with AFOS will allow for computer controlled collection and processing of observational data. Test and evaluation of weather equipment are conducted at Sterling, Virginia. This facility which has the capability to simulate a typical weather station, conducts tests of equipment and procedures under a wide range of environmental and operational conditions.

- o Specific Products. NWS also conducts ad hoc research and development to improve quality and timeliness of forecasts and warnings issued to the public. Research and development are conducted in the Systems Development Office, the Hydrologic Research Laboratory, the Regional Offices, the National Hurricane Center, the National Severe Storms Forecast Center, River Forecast Centers and many WSFOs to improve the forecasts of hurricanes, severe local storms, general weather, general flooding, flash floods and aviation weather conditions, using both dynamic and statistical techniques.

OTHER FUNCTIONS

Besides its four basic functions, NWS also carries out a number of other functions which are either:

- o Required to provide technical assistance and other services, or

- o Essentially supportive in nature.

This section identifies these functions and indicates the NWS organizational components that are mainly responsible for carrying them out.

Technical Assistance Functions. Besides developing and issuing weather reports, NWS provides a number of other services that essentially involve technical assistance, advice and consultation.

- o Disaster preparedness assistance is designed to improve the response by community officials and the public to forecasts and warnings. It is carried out with available resources by WSFOs, WSOs and warning preparedness meteorologists assigned to WSFOs primarily in the Eastern, Midwest, and Southern States. A Washington-based staff coordinates this program. The NWS effort is coordinated at all levels with the Federal Emergency Management Agency (FEMA) through a formal NOAA-FEMA Memorandum of Understanding.

Technical assistance to agriculture involves four Environmental Studies Service Centers (ESSCs) in Texas, Mississippi, Alabama and Indiana. These ESSCs provide technical services both directly and through their respective land grant colleges.

- The WSFOs and WSOs also provide direct technical assistance to Federal, State, and local governmental agencies, educational institutions, and the news media, as well as the general public.

- Technical assistance to communities in developing local self-help flash flood warning systems, nationwide.

- Technical assistance to Federal and State Forest and Land Management agencies is provided in the areas of training, observation instrumentation and site selection, and evaluation of weather related developmental programs.

- The Voluntary Co-operation Program provides meteorological assistance to less developed countries.

- International meteorological and hydrologic advice, consultation, and assistance are available upon request.

- NWS offices are involved in weather-related litigation activities and expert testimony.

- Climate services are offered by NMC (Climate Analysis Center), the WSFOs, the WSOs, the RFCs, and the ESSCs. NOAA's Environmental Data Information Service (EDIS) is also heavily involved.

SUPPORT FUNCTIONS

To operate and maintain NWS' various activities, substantial support functions are required. In common with other organizations, NWS requires a cadre of management and administrative personnel, but there is also more specialized support in a number of scientific and technical areas.

- Administration and management involves primarily national headquarters and NWS' six regional offices. Policy and procedural management is provided principally through the Weather Services Operations Manual.

- Engineering support involves facilities and equipment procurement, installation and management. Equipment maintenance and repair is a major item involving some 450 electronics technicians deployed throughout NWS's field structure and more than 10 percent of the agency's total budget.

- Research and development include efforts to improve forecast techniques, equipment systems and numerical weather prediction models, as well as equipment development and testing.

- Training in meteorology, hydrology, and equipment maintenance is carried out by the NWS Technical Training Center in Kansas City, as well as under contract through universities and other Federal agencies.

NWS also draws upon support services provided by other Departments and NOAA components, particularly the Environmental Research Laboratories and the National Ocean Survey. These organizations provide research and map production services, respectively.

PERFORMANCE LEVELS

NWS determines performance levels largely on an output basis, focusing on the basic forecasting subfunctions identified earlier. A key performance measure is accuracy, and NWS's national verification program determines accuracy measures for public weather and aviation forecasts for the NMC, the WSFOs and the WSOs. Within the WSFOs, accuracy is also determined on an individual basis. Similar verification programs are maintained for the NHC, NSSFC and the RFCs.

ENVIROMENTAL DATA AND INFORMATION SERVICE

Unless otherwise noted, Environmental Data and Information Service (EDIS) authority for its activities is contained in 15 USC 313, 49 USC 1463, and Department of Commerce Executive Order 25-5B. EDIS disseminates global meteorological and climatological data and information to meet the needs of users in commerce, industry, agriculture, the scientific an engineering community, the general public, and Federal, state and local governments. It also provides experiment design, data management, and analysis support to national and international meteorological research programs. It also assesses the impact of climatic fluctuations on yield of selected grain crops, energy demand and conservation, and other environmentally sensitive activities.

The EDIS National Climatic Center (NCC) is the custodian of U.S. weather records and is the largest climatic data center in the world. It also disseminates environmental satellite data. In addition, NCC houses World Data Center-A for Meteorology. NCC receives and processes millions of meteorological observations annually and makes data and related products available to a large, diverse user community. Data are gathered from the National Weather Service, the National Earth Satellite Service, military services, and international sources to provide a national climatic data base for multiple uses. More than 80,000 subscribers regularly receive published data.

NCC is working with other EDIS and NOAA components and the U. S. Department of Energy to quality control and validate solar radiation data taken in past years and combine them with other meteorological data in a form most useful for solar energy applications. NCC now can provide hourly solar radiation data or estimates for 241 locations in the United States. These data are used to determine the availability of solar energy for heating, cooling, and power generation systems. The Department of Energy is using the reworked solar data to develop typical solar radiation values for selected U.S. cities.

About one-third of all the energy consumed in the United States is used to heat, cool and operate homes, apartments, offices, and other buildings. It has been estimated that building-associated energy consumption could be cut by up to 40 percent if buildings were designed, sited and built by applying climatic data to minimize undesirable environmental effects and to maximize the impact of beneficial environmental elements. NCC and the American Institute of Architects Research Corporation are cooperating in a pilot project to define the influence

of climate on design criteria for residential housing. The goal is to provide specific guidance to engineers and architects so that homes can be designed to be responsive to the climate and thus reduce fuel consumption.

The EDIS Environmental Science Information Center (ESIC) publishes, announces and disseminates NOAA's meteorological scientific and technical publications, and provides for their continued availability through the National Technical Information Service (NTIS) and depository libraries throughout the United States. It promotes knowledge of U.S. and foreign meteorological research by sponsoring public access to a computer-searchable data base, Meteorological and Geoastrophysical Abstracts (MGA). MGA, the only index focusing exclusively on meteorology and related subjects, is produced by the American Meteorological Society with partial EDIS support.

ESIC's Library and Information Services system has one of the largest and most comprehensive collections of meteorological and climatological material in the world. It dates from 1890 and is the direct descendent of the Weather Bureau Library. Participation in a number of library networks permits sharing of materials nationally in support of meteorological research. Requests for meteorological information and data from other Government agencies, universities, industry, individual scientists, and the public are researched and answered. In addition, specialized information products are created to meet specific needs. These include: custom searches to produce comprehensive subject bibliographies upon request; Packaged Literature Searches, published computer-generated bibliographies on topics of broad general interest such as tornadoes, tsunamis, and weather modification; and Current Issue Outlines, information for decision-makers on high-interest environmental subjects.

The EDIS Center for Environmental Assessment Services (CEAS) provides assistance to managers of critical national resources by assessing the impacts of climatic variations on food and energy resources and of offshore energy developments on marine environments and resources.

CEAS prepares data-based studies and weekly assessments of potential effects of climatic fluctuations on national and global grain yields. These reports are used by the Departments of Agriculture and State and other Federal agencies, as well as by foreign governments and international organizations, to minimize the effects of grain production failures in any region of the world. In addition, NOAA/EDIS, the National Aeronautics and Space Administration, and the Departments of Agriculture, State and Interior cooperate in the Agriculture and Resources Inventory Surveys through Aerospace Remote Sensing (AGRISTARS) program that uses satellite crop monitoring, meteorological observations, and EDIS data-based computer models to make estimates of future crop production.

During the heating season, CEAS issues projections of residential and commercial natural gas demand for multi-state regions of the conterminous United States on a monthly and seasonal basis. The projections are based on an EDIS index of cold weather and on National Weather Service seasonal and monthly outlooks. They are provided to the U.S. Department of Energy and others responsible for energy use and planning. A similar service is provided for the summer cooling season.

Climatic anomalies, such as the two recent severe winters in the eastern United States (1977 and 1978) have heavy impacts on agriculture, energy consumption, and the national economy. To realize the enormous potential

benefits of predicting such anomalies, it is necessary to develop the capability to model and predict the general circulation of both atmosphere and oceans, as well as the exchange of energy, momentum, moisture, carbon dioxide, and other substances between them. A series of multi-nation major field experiments has been sponsored by international scientific bodies to collect the interdisciplinary environmental data needed for this effort. Under broad names, such as the Global Atmospheric Research Program (GARP), these programs have used sophisticated sensors mounted on extensive arrays of moored and drifting buoys, ships, airplanes, balloons and satellites, sampling at high rates under careful control. CEAS has played a key role in GARP experiments, providing experiment design, data analysis, and data management support to project managers, and producing merged, validated multidisciplinary data sets for international and national dissemination and study.

EDIS is supporting state-funded state climatologists. As of August 1980, there were working agreements with 42 states and negotiations are underway with the remaining states. The activity is designed to expand NOAA's climatic data/ information service capability to users at the local level; it provides a base from which to implement the intergovernmental climate program mandated by PL 95-367, Section 6.

The EDIS Reference Climatological Station (RCS) Program involves a network of 21 climatological stations serving as anchor points to stabilize the national network of principal and ordinary climatological stations. The latter stations suffer from changes in location, environment (natural and artificial) and exposure. Thus, continuity is interrupted and climatic changes can be estimated only by statistical techniques. The RCS anchor stations provide a "baseline" of climatological records, based on many years of observations in an undisturbed environment, thus providing a true measure of climatic trend. EDIS furnishes technical leadership, monitors and funds the program. The National Weather Service operates the stations and furnishes inspection and maintenance service.

Under Code 10 USC 7393 and an Executive Order of July 29, 1904, EDIS furnishes meteorological data and analyses to be included in the Defense Mapping Agency Hydrographic Center's Pilot Charts and Sailing Directions Planning Guides. In addition, EDIS' National Oceanographic Data Center publishes the Mariners Weather Log, which contains articles on meteorology and is the official record of weather and tropical cyclones over the world's oceans.

EDIS' National Geophysical and Solar-Terrestrial Data Center (NGSDC) provides archived and retrospective data and information services for the solid earthh and near-space environments. Its archives include paleoclimatic data and space environmental data required by environmental satellites.

NATIONAL EARTH SATELLITE SERVICE

Public Law 87-332 of September 30, 1961, provided the first appropriation for a national operational meteorological satellite system. This basic meteorological service observing program consists of polar-orbiting and geostationary satellites. The U.S. Department of Commerce, through the National Earth Satellite Service (NESS), is the agency responsible for a national operational environmental satellite system. The Department is charged with operating and improving the system to meet the common requirements of the Federal agencies. The objectives of the operational system are:

- Provide global imagery of the Earth and its environment on a regular basis, day and night, including direct readout to local ground stations within radio range of the satellite.

- Obtain quantitative environmental data on a global basis, such as temperature, moisture, winds, radiation flux, and solar energetic particle flux, for use in numerical analysis and prediction programs.

- Obtain near-continuous observations of the Earth and its environment, collect data from remote observing platforms (including automatic weather stations, balloons, aircraft, ships, buoys, and river and tidal stations) and broadcast weather data to remote locations.

- Improve monitoring and prediction of the atmospheric, oceanic, and space environments by developing applications of satellite information.

The operational satellite programs are directed toward satisfying the above objectives. The system also includes command and data acquisition stations; a satellite operations control center through which the satellites are controlled and data acquired; facilities for processing and analyzing satellite data and preparing products for distribution to the users; laboratories for developing new and improving existing applications of satellite data and conducting satellite instrument experiments; and programs for determining requirements of future operational satellite systems.

Satellite Field Services Stations (SFSS) have been established to analyze, interpret and distribute processed geostationary satellite products to regional National Weather Service offices and other Federal agencies. The products are also made available to private activities at their expense. SFSSs are located in Washington, DC; Miami, FL; Kansas City, MO; Honolulu, HI; San Francisco, CA; and Anchorage, AL. The Anchorage SFSS distributes data from both the polar-orbiting and geostationary systems. The San Francisco SFSS also has the capability of receiving data from the polar-orbiting satellites.

The TIROS N system of environmental polar-orbiting satellites replaced the ITOS system on July 15, 1979. TIROS N, the NASA prototype, was launched by the Atlas launch vehicle on October 13, 1978; and NOAA 6, the first NOAA-funded operational satellite of this series, was launched on June 27, 1979. NOAA-funded satellites retain the NOAA name and are numbered consecutively beginning with the number immediately following that last used in the ITOS series. Thus, NOAA "A" became NOAA 6 after it successfully achieved orbit. These satellites focus on increasing the accuracy of weather forecasting by providing quantitative data required for improved numerical models. They carry advanced instruments to provide improved temperature soundings and microwave channels to facilitate sounding retrieval in cloudy areas. They also provide advanced multichannel images and carry a new data collection and platform location system. During the lifetime of the TIROS N system, new instruments may be added or substituted for others. Therefore, the spacecraft are designed for a 25 percent growth capability in terms of weight, volume, power, command, and telemetry.

These spacecraft are five-sided boxlike structures that are 3.71 m long, 1.88 m in diameter, and weigh 1,409 kg including expendables. This third-generation system consists of two satellites in orbit; therefore, there is no

instrumental redundancy on either spacecraft. TIROS N was launched into a near-polar, sun-synchronous 870 km orbit, crossing the Equator in a northward direction at 1530 local time. NOAA 6 is orbiting at 830 km, crossing the Equator in a southward direction at 0730 local time. This compares with an average orbital altitude of 1,500 km for the ITOS satellites. TIROS N is flown at a somewhat higher altitude to avoid extended periods of readout conflict. The orbital period of the satellites is 101.58 minutes which produces 14.2 orbits per day.

The TIROS N system satellites carry four primary instrument systems. The Advanced Very High Resolution Radiometer (AVHRR) will provide data for real-time transmission to both Automatic Picture Transmission (APT) and High Resolution Picture Transmission (HRPT) users and for storage on the spacecraft tape recorders for later playback. Thus, the AVHRR instrument improves upon the ITOS satellite services in stored and direct readout radiometric data for day and night cloud, sea-surface temperatures and snow mapping. The data from the AVHRR instrument is available from the satellite in four operational modes.

- Direct readout to ground stations of the APT class worldwide, at 4-km resolution, of the visible and infrared data. Panoramic distortion is removed.

- Direct readout to ground stations of the HRPT class worldwide, at 1.1-km resolution, of all spectral channels.

- Global onboard recording of 4-km resolution data from all spectral channels. Global area coverage for commanded readout for processing in the NOAA central computer facility at Suitland, MD.

- Onboard recording of data from selected portions of each orbit at 1.1-km resolution of all spectral channels with local area coverage for central processing.

The TIROS Operational Vertical Sounder (TOVS) system combines data from several complementary sounding instruments on the spacecraft. These instruments are the High Resolution Infrared Sounder (HIRS/2), the Stratosperic Sounding Unit (SSU), and the Microwave Sounding Unit (MSU). The primary instrument providing tropospheric data, HIRS/2, is sensitive to energy from the visible to the carbon dioxide region of the infrared spectrum. This instrument is designed to provide data that permits calculation of temperature profiles from the surface to 10 mb, water vapor content at three levels of the atmosphere, and total ozone content. The SSU instrument, which is sensitive to energy in the carbon dioxide portion of the infrared spectrum, provides temperature information from the stratosphere. This instrument is provided by the Meteorological Office of the United Kingdom. The third instrument, the MSU, is sensitive to energy in the oxygen region of the microwave spectrum and will be used in conjunction with the two IR instruments. The microwave data permits computations to be made n the presence of clouds.

The Data Collection System (DCS) is provided by the Centre National d'Etudes Spatiales of France. The French call this the ARGOS Data Collection and Platform Location System. The ARGOS DCS provides a means to locate and collect data from fixed and moving platforms. It provides two new services not

currently present in the geostationary satellite data collection system. First, it has the capability to determine platform location, using an inverse Doppler technique. Second, it is able to acquire data from any place in the world, but more particularly in the polar regions, beyond transmission range of the geostationary satellites.

The Space Environment Monitor (SEM) measures solar proton flux, alpha particle and electron flux density, and energy spectrum and total particulate energy distribution at spacecraft altitude. The three detectors included within this instrument are the Total Energy Detector, Medium Energy Proton and Electron Detector, and High Energy Proton and Alpha Detector. This instrument will augment the measurements currently being made by NOAA's geostationary satellites. The data from the SEM will be processed at Suitland, MD, and transmitted over a dedicated data link to NOAA's Space Environment Laboratory at Boulder, CO, within one hour of the spacecraft readout. The TIROS N system data along with the geostationary data will be used to monitor the state of solar activity, which has a significant effect on terrestrial communications, electrical power distribution, and high-altitude flight in aircraft such as the Concorde SST.

Because of the large volumes of digital data generated by the TIROS N system satellites, a new ground system was required. The ground system consists of two major subsystems, the Data Acquisition and Control Subsystem (DACS) and the Data Processing and Services Subsystem (DPSS). The DACS includes components at the Wallops, VA, and Gilmore Creek, AL, Command and Data Acquisition (CDA) stations, the Satellite Operations Control Center (SOCC) in Suitland, MD, the Western European Station in Lannion, France, and the Satellite Field Services Station in San Francisco, CA. All the DPSS components are in the NOAA facility at Suitland.

DACS includes all components necessary to command and control the spacecraft, monitor its health via housekeeping telemetry, and retrieve and transmit the spacecraft environmental data to the DPSS processing and data handling facility. The delivery of TIROS N system data from the CDAs to Suitland is accomplished using the RCA American Communications, Inc., commercial satellite communications network. This system, which includes recently installed Earth Stations at Suitland and Wallops, deliver the data to SOCC. These data are immediately passed on to the DPSS subsystem for initial processing. This new ground system was accepted in February 1979.

During three sequential orbits and occasionally four on some days, the spacecraft is out of range of both NOAA CDA stations. To eliminate the resultant time delay in the receipt of the high-priority sounding data during the "blind" period, a Western European readout station was established at Lannion, France. This station acquires stored sounding data and transmits it to the United States via the eastern GOES satellite located at 75W.

The DPSS ingests the raw satellite data, and preprocesses and stores them along with appended auxiliary information such as Earth location and quality control parameters. DPSS consists of several unique segments of high-speed computers, intermediate disk storage units and a mass data storage system. Thus, all the data obtained from a single TIROS N system spacecraft for a 24-hour period can be stored on a single tape.

Central Data Distribution Facility for Geostationary Satellites

This facility extracts sectors of the geostationary satellite (GOES) full-disc data. The "sectorized" data is then sent to the National Weather Service forecast offices and other users (Department of Defense, television stations, and universities) who have arranged to receive data for their specific areas of interest.

The geostationary satellite program began during the latter half of the 1960s as an operational experiment in which the imaging capability and broadcast system (WEFAX) of the NASA Applications Technology Satellites 1 and 3 were used. The program became an operational reality following the launch of NASA's Synchronous Meteorological Satellites (SMS) 1 and 2 in 1974 and 1975, respectively. NASA released to NESS both SMS 1 and 2 for operational control and use following the initial checkout period. These satellites were the prototypes for NOAA's Geostationary Operational Environmental Satellites (GOES). GOES 1 was launched October 16, 1975, GOES 2 was launched June 16, 1977, GOES 3 was launched June 16, 1978, and GOES 4 was launched September 9, 1980. SMS 2 is the eastern (75 W) operational satellite, and GOES 3 is the western (135 W) operational satellite. GOES 1 was moved to 60 E over the Indian Ocean in December 1978, to support the Global Weather Experiment from December 1, 1978, to November 30, 1979. After the experiment GOES 1 was relocated at 131W. SMS 1 and GOES 2 remain in orbit in a standby mode. GOES 4 has been checked and will replace GOES 3 as the western operational satellite. The eastern and western satellites provide repetitive viewing of the development and movement of destructive weather systems, such as thunderstorms, hurricanes, and major mid-latitude storms over much of North and South America and adjacent oceans. The principal instrument is the Visible and Infrared Spin Scan Radiometer (VISSR). The VISSR provides near-continuous cloud viewing with resolutions of 1, 2, 4 and 8 km in the visible wave lengths and 8 km in the infrared wavelength. Full Earth disc pictures are available at 30-minute intervals throughout the day and night; partial disc pictures can be obtained at more frequent intervals to meet special requirements such as viewing development and movement of severe storms. GOES 4 will have a dual research-operational mission. For the first time, the concept of obtaining atmospheric soundings from geostationary satellites will be tested. GOES 4 carries a VISSR Atmospheric Sounder (VAS) which has both an imaging and a sounding capability. The additional capabilities of the VAS are the multispectral imaging--VAS has 12 infrared channels whereas the VISSR has only one--and the ability to derive temperature and moisture profiles. Additionally, the VAS can be programmed to select the area of interest, the data of interest, and the frequency of coverage. Sounding from a geostationary satellite would afford several advantages over sounding from a polar-orbiting satellite. They are: constant surveillance, constant viewing geometry, better determination of temporal and spatial gradients, easier comparison with radiosondes, and synoptic large area coverage. An experimental VAS data handling system has been built under the aegis of NASA's VAS Demonstration Program. This has resulted in a joint NOAA/NASA project called Centralized Storm Information System. Its future development and direction of operational meso-meteorological systems will be influenced by the outcome of the VAS demonstration on GOES 4. The GOES data collection system is used to collect and relay environmental data observed by remotely located river and tide gages. These satellites also broadcast environmental data to remote locations using the WEFAX system, and collect data for warnings of solar activity using the Space Environment Monitor. Table B-1 shows the launch schedule for polar orbiting and geostationary satellites by the Department of Commerce.

Interactive Computer System for Processing Geostationary Satellite Data

This system is used by the National Earth Satellite Service (NOAA) to provide the location on the Earth of geostationary satellite (GOES) data. It can also be used, in real time, to determine the height of clouds by using the satellite cloud-top temperature data together with the metoeorological fields (including temperature-vs.-height data) from the National Meteorological Center.

POLAR-ORBITING SYSTEM

Satellite Designator	Planned Launch Date	Instruments TIROS N Series
NOAA C	FY 1981*	AVHRR - Advanced Very High Resolution Radiometer
NOAA D	FY 1982*	
NOAA E	FY 1983*	TOVS - TIROS Operational Vertical Sounder
NOAA F	FY 1984*	
NOAA G	FY 1985*	SEM - Space Environmental Monitor
NOAA H	FY 1986*	DCPLS - Data Collection and Platform Location System (ARGOS)
NOAA I	FY 1987*	
NOAA J	FY 1988*	SBUV - Solar Backscatter Ultraviolet Instrument (starting with NOAA F)
		SAR - Search and Rescue Instrument (starting with NOAA E)
		ERBI - Earth Radiation Budget Instrument (NASA-funded instrument to be flown on NOAA F and G. NOAA-funded instrument on NOAA H and I)

GEOSTATIONARY SYSTEM

Satellite Designator	Planned Launch Date	Instruments
GOES E	FY 1981*	SEM - Space Environment Monitor
GOES F	FY 1982*	DCS - Data Collection System
GOES G	FY 1985*	VAS - VISSR Atmospheric Sounder (GOES D and subsequent spacecraft)
GOES H	FY 1986*	
GOES I	FY 1988*	

*Launch date depends on performance of prior spacecraft.

Table B.1
PROJECTED SATELLITE LAUNCH SCHEDULE

RESEARCH PROGRAM FOR FY 1982

The NESS research programs in FY 1982 will be devoted to the development and improvement of quantitative data and products (from satellite observations) that are useful for national and international climate programs, agriculture, fisheries, energy, and other weather and land applications. With the addition of new sensors on board both polar-orbiting and geosynchronous satellites, techniques will be developed to improve the algorithms to derive accurate temperature and moisture distributions that are essential for weather analysis and forecasting. Data received from the VAS instrument will be used in mesoscale meteorological studies and, in particular, to study the life cycle of severe storms over the United States. VAS data will be combined with other data received from the Prototype Regional Observing and Forecasting Service (PROFS) experiment to study the structure of short-lived weather phenomena.

Satellite data received from the operational and research satellites will be used to derive improved earth-atmosphere radiation budget parameters that are essential for the climate analysis, diagnostics, and monitoring (at the Climate Analysis Center). Since the national and international climate programs consider the earth-atmosphere radiation as the most important parameter needed in various activities, NESS will concentrate its efforts in this area and study the effects of clouds and their influence on the radiation budget.

In addition, NESS will focus on the improvement of sea surface temperature mapping for climate and other studies through the multispectral measurements and the development and testing of bio-optical techniques for NOAA-related fisheries application using data from the Coastal Zone color scanner on the Nimbus-7 satellite. Other application research areas involve improving techniques to estimate the wind speed and intensity of tropical storms using satellite visible and infrared observations; estimation of precipitation and solar insolation reaching the ground; and other geographical, geological, and hydrological parameters from operational and research spacecraft, including Landsat. All these application-oriented research efforts will make extensive use of interactive data processing and display systems.

SATELLITE COMMUNICATIONS SYSTEM

The NESS Telecommunications System (SATCOM) is divided into two discrete subsystems, one serving the NOAA polar-orbiting satellites (NOAA) and the second serving the geostationary satellites (GOES) and the associated Satellite Field Services Stations (SFSSs). The major elements in the polar-orbiting satellite subsystem are the CDA stations at Wallops, VA, and Gilmore Creek, AL, and the Satellite Operations Control Center in Suitland, MD. The synchronous satellite subsystem connects the Wallops CDA station with the Central Data Distribution Facility (CDDF) at Camp Springs, MD.

The CDDF is connected in turn with the Gilmore Creek CDA station, with the six SFSSs located in Washington, DC; Miami; Kansas City; San Francisco; Anchorage; and Honolulu; and with the NWS San Juan, PR, WSFO. The Gilmore Creek CDA station also relays satellite data by two satellite distribution circuits to the Anchorage SFSS and the NWS WSFOs at Anchorage, Fairbanks and Juneau.

By the end of FY 1980, SATCOM consisted of the following high- and medium-speed links:

- Three simplex and one duplex terrestrial microwave circuits consisting of two simplex circuits for delivery of stretched VISSR data to the World Weather Building (WWB), Camp Springs, MD (1.75 Mbps), one simplex test circuit from WWB to Federal Office Building #4 (FOB #4) at Suitland, Maryland (1.75 Mbps), and one full duplex circuit for 1.5 Mbps digital data service.

- Two full-duplex, full period C2 conditioned voice grade satellite and terrestrial data circuits connecting FOB #4 with the Anchorage SFSS and Gilmore Creek CDA station for facsimile.

- One C-5 conditioned full-duplex circuit from computer output at the CDDF to display units at the SFSSs, and further transmission to nationwide users.

- One C-5 conditioned full-duplex circuit from the Suitland FOB #4 computer to the Wallops CDA station to transmit WEFAX information.

- One full-duplex, full period voice-grade circuit conditioned for digital transmission from the Wallops CDA station to the WWB for relay of GOES Data Collection System (DCS) information.

- Additional digitally conditioned circuits, dedicated and dial-up for delivery of DCS information from the WWB to a multitude of users. Computer-to-computer transmission is used in most cases.

- Two voice networks connecting all SFSSs, FOB #4, and Wallops CDA.

- One digitally conditioned circuit between FOB #4 and WWB for transmitting temperature sounding data used for interactive processing.

- One digitally conditioned voice-grade circuit for transmitting FAA Service "C" data to interactive computers in the WWB.

- One C-2 conditioned circuit for transmitting digital radar data from Patuxent Naval Air Station, Patuxent River, Maryland, to the WWB.

- Five C-5 conditioned voice-grade, full period, full-duplex circuits from Wallops CDA to WWB (two circuits), Kansas City SFSS (two circuits), and Miami SFSS (one circuit) for transmitting east and west GOES data.

- One 50-line and one 40-line multipoint voice coordination and conferencing network connecting NESS operating facilities.

- One 15-line multipoint voice coordination and monitoring network at Suitland for control and integration of launch activities.

- Two 100 wpm multipoint teletypewriter circuits connecting various elements of SATCOM.

- A direct alternate voice, data, or facsimile circuit between Washington and Moscow for exchange of satellite information.

- Two 1.3308 Mbps simplex satellite circuits for relay of TIROS N data from the two CDA stations to Suitland, MD, and the RCA Ground receiving station at Offutt Air Force Base, NE.

- Four alternate 9,600 hertz data/teletype and voice full duplex satellite and terrestrial circuits between the two CDA stations and Suitland, MD, to relay real-time TIROS N data, to transmit command and control functions to the NOAA spacecraft, and to provide alternate routing and backup for NOAA teletype and voice communications.

- Two full-duplex combination teletype and voice satellite and terrestrial circuits between the two CDA stations and Suitland, MD, for coordination of NOAA operations.

- One simplex C-5 conditioned data facsimile circuit between the Wallops CDA station and Suitland, MD, for the relay of sectorized NOAA HRPT data.

ENVIRONMENTAL RESEARCH LABORATORIES

Environmental Research Laboratoaries (ERL) R&D programs related to basic meteorological services are oriented toward providing the understanding and developing the techniques and new technologies that will form the basis for future improvements in the nation's weather services. The responsibility for work on this important function encompasses the mission of several ERL laboratories.

Severe weather is any major natural hazard such as flash flood, strong winds, thunderstorms (including tornadoes and hail), heavy snowstorms and clear-air turbulence affecting aviation. From the health standpoint, air pollution can be considered a hazard although it results from human activities. The above phenomena are all associated with small- to medium-scale disturbances in the atmosphere.

The Prototype Regional Observing and Forecasting System (PROFS) objective to improve local weather services has been refined to include early technology transfers to National Weather Service (NWS) operations. PROFS has been charged with the establishment of a capability to acquire, interactively manipulate, and display conventional meteorological data, satellite and radar data, and data from local surface networks. The initial goal is to enhance the NWS capability to provide severe-weather and flash-flood warning services. During FY81, PROFS has established communications links for acquiring the necessary data for the Exploratory Development Facility (EDF), and developed the hardware/software capability in the EDF to manipulate, process, and display these data. Based on subsystem capability testing performed during FY81, PROFS will hand off an initial design for improved short-term, local weather services to the NWS in the first quarter of FY82. More detailed systems testing, assessment, and evaluation will be accomplished during FY82 that will result in a major incremental system design transfer to the NWS in FY83.

The Wave Propagation Laboratory will be initiating tests of an automatic, unmanned, remote sensing system for the continuous profiling of winds, temperature, and humidity during FY81. The system comprises a six-channel microwave radiometer for the profiling of temperature and humidity, and a VHF Doppler radar for the profiling of upper atmosphere wind speed and direction, and tropopause height. In FY82, a UHF Doppler radar will be added, to provide lower atmosphere wind information and the height of low-level temperature inversions. This effort is being partially supported by and will be used in the PROFS program.

The National Severe Storms Laboratory (NSSL) in Oklahoma concentrates its research effort on severe local storms, especially those phenomena associated with intense thunderstorms. NSSL scientists, in cooperation with and support by the National Weather Service, the Federal Aviation Administration, and the Air Weather Service have demonstrated that pulsed Doppler radars can sense developing circulations preceding large tornadoes some 10 to 20 minutes prior to tornado touchdown. Although these radars have been principally used to map turbulence and wind fields within areas of precipitation, Doppler weather radars can also sense wind in the prestorm environment thus opening a path toward possible improvement in thunderstorm forecasts. Funds permitting, the radars

will be upgraded with increased sensitivity and dual-polarization capability, to improve their clear air wind mapping performance. The upgraded radars will be used to map air motions well before precipitation develops within them.

Additional new computer resources will be utilized to incorporate these new data in numerical models of deep convection and mesoscale processes. Airborne and ground-based lightning sensors will be used to study cloud electrification processes and the role of lightning in the thunderstorm cycle. Ultimately, the interactions among co-evolving wind, water and electrical fields will be defined and understood and translated into improved identification and warning of the related hazards.

The new Office of Weather Research and Modification (OWRM) is developing techniques and technologies to improve short-term weather forecasts of significant weather events. Scientists are performing detailed analyses of recent flash flood episodes, and developing regional climatologies to identify common features useful for forecasting. Pioneering work continues in the development of mesoscale numerical models capable of simulating air flow, clouds, and precipitation over mountainous terrain. Snowfall and heavy convective rains in mountainous areas are of particular interest. A project to gather data for testing a mesoscale numerical model was conducted during the summer of 1980 in Hawaii. This data will be processed and used to compare with model output in FY81. OWRM scientists continue to transfer flash flood forecasting techniques to the NWS through lectures given several times a year at the NWS Training Center.

A technique for estimating convective rainfall using satellite observations has reached a level of proficiency that is justifying its operational use. OWRM scientists working in conjunction with the NWS Hurricane Forecast Center, have adapted this technique for hurricanes. Real-time estimates of the rainfall accompanying hurricane landfall were available to forecasters for the first time in 1980. Work will continue in FY81 to improve this technique which also has important applications to the flash flood warning problem.

Eyewall and rainband studies were conducted during NOAA P-3 aircraft flights into Hurricane Allen in early August 1980. Data were sought on the time-evolution of the storm's center by Atlantic Oceanographic and Meteorological Laboratories scientists. Wind speeds of 170 kts were the highest ever recorded at 5,000 ft. Project Hurricane STRIKE will continue in FY 1981 and FY 1982 as a cooperative program with NWS and the universities to improve and extend the prediction of landfalling hurricanes. Primary objectives for this Project are:

a) Improved 24-hour prediction of the place and time of hurricane landfall.

b) Development of new prediction products for landfalling hurricanes (e.g., charts of wind damage potential, charts of flooding potential).

c) Improved understanding of changes in hurricane motion, intensity and structure as a result of a hurricane approaching land.

d) Expanded real-time transmission to forecasters of data gathered by research aircraft in hurricanes approaching landfall (some of this was achieved during 1980 hurricane season).

The Geophysical Fluid Dynamics Laboratory in Princeton, NJ, does numerical modeling research of direct relevance to meteorological services. Three main activities are covered in this work. The first, experimental prediction, is the largest, and has four goals:

- o To develop or improve atmospheric predicton models suitable for the time range from five to 30 days.

- o To identify important external forcing mechanisms and additional internal processes, which are required by models to simulate the evolution of macro-scale atmospheric disturbances over the range of several weeks to four months.

- o To search for a physically-based probabilistic approach for long-range simulation of atmospheric variation, given a suitable initial specification of the atmosphere, ocean, soil, and snow-ice.

- o To study the mechanisms of particular atmospheric phenomena such as tropospheric blocking, orographic cyclogenesis, tropical easterly waves, and sudden warming.

The second main activity is the study of hurricane dynamics, including the genesis, development and decay of tropical depressions, and the study of small-scale features within hurricane systems.

A third area concerns mesoscale dynamics, where the goals are:

- o To produce accurate numerical simulations of mesoscale processes in order to understand what role synoptic scale parameters play in their generation and evolution, and

- o To understand the internal gravity waves (generation, interaction, and breakdown) that are strongly connected with the diffusive processes in the atmosphere and ocean.

DEPARTMENT OF DEFENSE

The Department of Defense (DOD) operates a military environmental service system to provide specialized worldwide meteorological and oceanographic prediction services in support of military forces. This service directly supports all phases of military operations, from strategic planning to tactical operations. The U. S. Navy's Naval Oceanography Command and the U. S. Air Force's Air Weather Service are the primary military performing agencies. The Army and the Marine Corps each have a small generic weather support capability, but depend upon the primary weather services for most support. The military weather services contribute to the national and international weather observing capability by making conventional observations on land and at sea where there is no other conventional weather observing capability and where the observations are most needed to meet military requirements. In addition, DOD maintains special observing capabilities such as the Defense Meteorological Satellite Program and aerial weather reconnaissance to meet unique military requirements. The reconnaisance program also serves national needs for data from tropical and coastal winter storms. Observational data are sent by military communications networks to military and civil facilities in the United States and overseas.

UNITED STATES ARMY

ORGANIZATIONAL ELEMENTS AND STRUCTURE

Environmental services personnel and other personnel concerned with meteorological activities and related equipment development and funding serve in the Department of Army staff sections of the Assistant Chief of Staff for Intelligence, (ACSI) the Deputy Chief of Staff for Research and Development and Acquisition, (DCSRDA) Deputy Chief of Staff, Operations and Plans (DCSOPS) and the Chief of Engineers (OCE). ACSI is the focal point for Army environmental services matters. DCSRDA and OCE are responsible for environmental research, development, test, and evaluation. DCSOPS arranges for allocation of communications frequencies for radiosonde, radar, and other electronic systems used by Army environmental services units. DCSRDA provides life cycle management of meteorological equipment. DCSOPS establishes priorities for meteorological equipment and systems development and procurement. OCE has responsibility for providing specialized river and flood forecasting services and hydrologic data for the US Armed Forces.

The Army has 29 authorized artillery ballistic meteorological sections located throughout the world. Their primary function is to provide accurate environmental data for correction of artillery firing. In addition, data are provided to other elements of the Army for sound ranging and Chemical/Nuclear Defense operations, fallout forecasts, and the AWS units for synoptic purposes. The 201A warrant officers and 93F Ballistic observors are the artillery personnel used to accomplish their meteorological functions.

The primary mission of the Army, related to meteorology, is to maximize worldwide combat and strategic effectiveness by continually improving Army-required atmospheric related products. The Army role is defined in AR 115010/ AFR 105-3, 15 September 1980.

Army research emphasis today is being placed on atmospheric transmission problems associated with electro-optics, near millimeter waves, and high-energy laser weapons; on artillery and rocket ballistic problems; on the development of new equipment and systems for the field Army; on providing techniques and meteorological support for the research, development, and testing of materiel, systems, and equipment; and on making up-to-the-minute atmospheric information available at the corps or "mesoscale" level.

BATTLEFIELD OBSCURATION EFFECTS - ELECTRO-OPTICAL/MILLIMETER/MICROWAVE

The principal objective of the Army's electro-optical (E-O) and/near/millimeter wave (NMMW) program is to have a means by which atmospheric effects of E-O and NMMW systems can be determined for weapons developers, systems analysts, war gamers, tacticians, and modeling testers without resorting to expensive, time-consuming testing of these systems under simulated, low visibility battlefield conditions. This program includes measuring and modeling of electromagnetic energy through battlefield-type atmospheres and the characterization of low visibility battlefield conditions. The efforts are consolidated in the Electro-Optical Systems Atmospheric Effects Library (EOSAEL).

During FY80 efforts have centered on making improvements to several of the EOSAEL modules, streamlining some of the computer routines, developing new models, interfacing with user organizations, distributing the interim version, and analyzing obscuration data. Formal requests for documentation relating to Interim EOSAEL have been received from approximately 35 organizations.

The Disturbed Infrared Tranmission (DIRTRAN) Code, a computer module in EOSAEL, has been expanded to include the capability of addressing multiple burst scenarios, calculating slant path transmission, and modeling obscuration produced by vehicular-generated dust. The existing vertical profile data for fog and haze from Meppen and Grafenwohr, Germany, were reanalyzed and an improved empirical model was developed. Fog drop size data from Meppen, Grafenwohr, and Greding, Germany, and visible and infrared transmission data from Baumholder, Germany, have been characterized by air mass over the region at the time of measurement.

The obscuration at visible, infrared, and millimeter wave lengths experienced on the battlefield is produced by meteorological events such as fog, rain, and snow; smoke either deliberately employed or that associated with burning material, firing of weapons, and explosions; dust lofted by explosions, wind, or vehicular activity; and optical turbulence. A qualitative description of battlefield obscuration emphasizing central Europe has been prepared.

Meticulous high-resolution laboratory measurements are being made at infrared and near millimeter wavelengths to determine propagation characteristics and effects of temperature, pressure, and water vapor. Measurement techniques and specialized sensors are being developed to measure extinction, absorption, and liquid water content.

Adverse Weather Obscuration

The degree to which meteorological events produce obscuration is dependent upon several factors such as the size distribution of the aerosols associated with the event, the concentration of aerosols, and the wavelength of the viewing device. The obscurants vary in space, including the vertical, and in time. Hazes have few large diameters (e.g., particles greater than 10 micrometers in diameter) and hence for short ranges (i.e., ranges less than 5 km) do not produce much obscuration. On the other hand, fogs can produce major obscuration at visible and infrared wavelengths. The relative amount of obscuration at infrared wavelengths to that at visible wavelengths depends principally on the type and maturity of the fog, i.e., on the size distribution of the aerosols. Because millimeter wavelength radiation is much longer than the diameter of either fog or haze aerosols, obscuration at millimeter wavelengths is normally minor. However, rain and snow can cause major obscuration at visible, infrared, and millimeter wavelengths. The obscuration produced by these and other meteorological elements is known as adverse weather obscuration.

Fog optical models (or rather empirical relationships between the liquid water content of fog and visibility) have been in existence for over 40 years. Only lately has attention been directed towards relationships in other than the visible portion of the spectrum because of the interest in sensors operating at infrared wavelengths. Fog data taken at Meppen, Germany, during the winter of 1978, has been examined and implications drawn about the effect of fog at visible and infrared wavelenghs. Since visibility is a regularly observed quantity in meteorology, it would be desirable to use it to estimate transmission for infrared wavelengths. By constructing bimodal aerosol-size distributions on the basis of bracketed visibility values, it has been demonstrated that fog optical properties at infrared wavelengths can be satisfactorily determined.

In addition to horizontal variations in fog and haze, the density of fog and haze varies considerably with altitude above ground level. The effects that such vertical inhomogeneities can have on the performance of air-to-ground weapon systems is not well known. A major field experiment was designed to address this problem by making an extensive set of interrelated atmospheric optical, physical, and meteorological measurements continuously for a six-week period in the fall of 1980 at Meppen, Germany. The heart of the measurement program consisted of profiles of fog droplet size distributions as a function of altitude from ground level to an altitude of 1 km. Lidar measurements were made at 1.06 and 10.6 micrometers in an attempt to produce quantitative fog-density profiles. A 80-meter tower was used for meteorological measurements and to hold sources for visible wavelength slant path transmission measurements. Intercomparisons were made of several fog droplet size distribution measurement methods and of several liquid water content measuring techniques. Regular OPAQUE (Optical Atmospheric Quantities in Europe) measurements were made. Visibility meters were left on the tower to obtain a longer data base.

The atmospheric effects on millimeter waves have been assessed. Near millimeter wave (NMMW) models have been constructed for gaseous absorption, rain extinction, fog (ice and liquid) absorption, and cloud absorption. Work has begun on a NMMW snow obscuration model. In addition to these state-of-the-art models, less general models have been developed for EOSAEL to quantify gas, rain, fog, and cloud extinctions. Improvements over the NMMW models for Interim EOSAEL include full frequency computations over the 10-350 GHz range, improved rain and gas models, and the inclusion of ice fog.

The Transportable Atmospheric Characterization Station (TACS) has been developed and utilized to define atmospheric effects on millimeter wave propagation. The TACS will be utilized in conjunction with Harry Diamond Laboratories' Mobile Measurement Facility and will measure relevant environmental properties such as drop-size distribution and concentration of rain, fog, snow, humidity, temperature, canopy moisture, and soil moisture. A high-speed Lyman-alpha hygrometer has been built to measure high-speed fluctuations in the atmospheric water vapor density of interest to NMMW scintillations.

Smoke Obscuration

In a manner analogous to that for fog, the obscuration produced by smoke depends on various factors such as the size distribution of the smoke particles, the concentration, and wavelength of the viewing device. In addition, the chemical/optical properties of the smoke are important. Some smokes, such as WP, are hydroscopic; others are not.

Unique relations independent of particle size distribution have been shown to exist for single scattering regime between the volume extinction coefficient and the mass content throughout the infrared for highly absorbing RP and FS smokes. However, a similar unique relation was not found for weakly absorbing HC or fog oil smoke. For carbonaceous smokes, similar relations were found for visible wavelengths in spite of the fact that carbon particles have markedly irregular shapes. These extinction-mass relations are valuable in modeling the radiative effects of smoke obscurants because the extinction coefficient, and also in some cases the single-scattering albedo and the backscatter coefficient, can be inferred solely from knowledge of the smoke mass concentration.

Dust Obscuration

Battlefield dust, whether natural, wind-borne, or that thrown up by high explosives or vehicular movement, affects the performance of E-O systems at both the visible and infrared wavelength. Moreover explosive dust and debris can affect millimeter wave systems for short periods of time.

Methodologies have been developed to describe the interaction mechanisms and importance of physical properties at each stage of the dust obscuration process. Computer models have been developed to couple the optical properties, meteorological dependence, and source characterization to transmission through a dusty battlefield environment. The greatest uncertainties in artillery produced dust have been found to follow from variation in soil textures, moisture content, and explosion depth. Scaling laws which relate these factors to the amount of lofted dust have been developed based on extensive field measurements. Modeling of optical effects due to time variation in the proportional number of particles of each size due to settling has also been performed. Dust raised by tracked vehicles is also being modeled.

Field measurements of the temporal evolution of the size distribution and concentrations of aerosol particles generated by various types of explosives during summertime conditions at WSMR have shown that a single 7-pound composition - 4 explosive caused a dust cloud with peak concentrations of 0.3 g/m^3 at ground level 100 meters from the explosion site. The dust clouds are very inhomogeneous. Nevertheless, the size distribution of particles has a similar

form throughout the cloud and can be approximated with a lognormal distribution with mean radius at 0.9um and geometric standard deviation of 2.3. If the charge were buried, a significant fraction of the dust and debris particles consisted of, or contained, carbon. The remaining particles appeared to be soil-derived.

The third, and possibly last, in the series of Dusty Infrared Tests (DIRT III) was conducted at Fort Polk, LA, during April-May 1980. The main thrust of DIRT III was to characterize the transmission of electromagnetic energy through dust clouds produced by high explosives and ammunitions at wavelengths used by the Army for laser guided munitions, night vision devices, and target acquisition. To do this, sophisticated instrumentation was used at wavelengths of 0.55, 1.06, and 10.37 micrometers and at a frequency of 95 GHz. In order to understand the interaction of the dust cloud with the transmitted energy, extensive conjunctive and simultaneous measurements were made of cloud particle size distribution dynamics (size, growth, dispersion, and drift), and meteorological conditions.

DIRT III was two tests in one. The first portion examined the effects of single, ground-borne, static detonations of foreign and domestic artillery to visible, infrared, and millimeter transmission. The Fort Polk soil and climatology offered a marked contrast to the previous tests conducted in the semiarid environment of WSMR. High explosives were also detonated to determine crater equivalence between cased and bare charges.

The second part of DIRT III addressed the transmission of electromagnetic energy through dust clouds produced from a variety of soil types with varying particle size and moisture content. Soils used to produce the tailored soils were sand, silt, clay, and kaolin.

The wet native soil, sandy loam over heavy clay, did not produce the large, dense dust clouds observed during DIRT I and DIRT II at WSMR; nevertheless, significant attenuation was observed at all wavelengths. Visible and infrared one-way transmission was completely blocked on numerous tests. The 95 GHz radar of NVEOL observed major signal attenuation and backscatter for both on-axis and off-axis explosions.

The tailored soil tests showed very clearly the influence of water on transmission. Dry soils yielded little backscatter or attenuation for the 95 GHz signals, while the same soil with water added produced measurable effects.

HIGH ENERGY LASER ATMOSPHERIC CHARACTERIZATION

The US Army Atmospheric Sciences Laboratory (ASL) has been designated lead laboratory for meteorological support to the DOD National High Energy Laser Test Range, New Mexico, and has the responsiblity for developing and implementing a technology, measurement, prediction, and meteorological support program for NHELTR.

This support crosses the technical base and meteorological operational support lines. The technical base program addresses (a) development of specialized site peculiar measurement techniques and equipment, (b) establishment of optical turbulence, crosswind, gases, particulates and site

peculiar micrometeorological data bases, and (c) specialized data reduction and analysis techniques and development of operational techniques to characterize the atmosphere. The operational meteorology program (a) identifies operational support from scenarios provided by each service, (b) tailors support to the mission, (c) makes predictions of propagation conditions for tests, and (d) provides operational support including post-test analysis.

ELECTRO-OPTICAL CLIMATOLOGY

This program provides climatology for Army battlefield obscuration projects through tailored climatological summaries, models, and dynamic weather scenarios. Approaches include computing climate statistics for Army areas of interest, simulating typical weather for a scenario, probabilistic climate estimation models for missile homing and guidance.

Historical weather records for a large number of stations in central Europe, and a few selected stations in the Mid-East, Korea, and Alaska were obtained from the Air Force Environmental Technical Applications Center. These data were analyzed and a climatology module, CLIMAT, was developed for the EOSAEL. CLIMAT contains means, standard deviations, and some probability of occurrence estimates for most standard meteorological parameters for each hour of the day and each month of the year for each of six climatic regions in West Germany. The historical data is also used to provide tailored climatology, statistical summaries, and simulated weather sequences to Army agencies upon request. Several useful meteorological parameters for the analysis of E-O systems effectiveness are provided which are not included in standard meteorological data. These include transmission at various IR wavelengths, precipitation rates, types of fog, and liquid water content.

METEOROLOGICAL EQUIPMENT

One of the major meteorological equipment development projects is the Automatic Atmospheric Sounding Set AN/TMQ-31 (the Field Artillery Meteorological Acquisition System), designed to replace the aging AN/GMD-1 rawinsonde system for the measurement of upper air windspeed and wind direction, temperature, humidity, and pressure. The AN/TMQ-31 is the newest type equipment that provides accuracies, capabilities, flexibility, and features not available in other atmospheric sounding systems. It is being designed in support of Army artillery fire, but also provides data for other Army users. The purpose of the AN/TMQ-31 is to give the artillery sections the improved capability of first round hits, even in areas obscured from observers, by providing reliable, fresh (hourly) and comprehensive meteorological data. These data are obtained through the available passive techniques of NAVAID or RDF radiosonde tracking systems. The AN/TMQ-31 combines both techniques into a small system in which the fully automatic ground receiving, computing, display and transmitting equipment are housed in an S-280 shelter (on a 2-1/2 ton truck) and the RDF antenna/pedestal is on a 1-1/2 ton trailer.

Effort is also under way on an improved AN/TMQ-31 antenna to provide improved low angle tracking (ideally down to 6.5^{o}). The improved antenna will exhibit reduced weight and size along with decreased march order time. This work is expected to transition into a product improvement program (PIP) in FY82.

With the AN/TMQ-31 still under development, the Meteorological Data Processing Group OL-192 was fielded in FY79 as an improvement to the GMD-1 and incorporates a sophisticated calculator solution to replace manual computations. The calculator, somewhat like a minicomputer, speeds up plotting procedures used to convert raw meteorological data into ballistic meteorological messages. The calculator will permit reduced personnel, increased firing accuracy, and more frequent observations. The OL-192 has operated satisfactorily with no deficiencies in all testing and is being fielded throughout the world. One calculator was on its way to Camp Stanley, Korea, in February 1980; another thirteen of the devices were sent to Germany last autumn; twenty-three more were sent to Forces Command; and several dozen were sent to Fort Sill, OK, for National Guard training units. About 150 of the OL-192s will be fielded over the next several years.

ARTILLERY METEOROLOGY

The main thrust of this effort is to increase the effectiveness of artillery fire by reducing inaccuracies in artillery fire due to meteorological conditions and to reduce munition expenditures. This will be accomplished by reduction of the meteorology portion of the artillery error budget through the development of improved sensing systems and techniques for data utilization and incorporation of meteorology into the calculation of smoke munition expenditures. Results of these efforts will be an overall increase in artillery effectiveness and lethality.

Efforts in sound ranging address the problem of enhanced accuracy in target location through algorithms and meteorological applications. Two software packages were completed, one with and the other without a CRT display. The cassettes of the prototype versions are being evaluated by the US Army Field Artillery Board. The program was designed for operation on a desk top calculator envisioned for future use by Target Acquisition Sections and included such functions as sound ranging, flash ranging, laser range finding, flash ranging adjustment, sound on sound adjustment, and a computer aided assistance to reading of strip charts for time break determinations.

A concept to use an array of acoustic microphones as a remote meteorological sensor was mathematically developed. The concept requires interpretation of sound ranging acoustical break time data in terms of meteorological effects on the propagation of acoustic energy. The timing data is mathematically inverted (convoluted) to yield "apparent" average meteorological data over the acoustic path. The technique, if proven feasible, offers an improved capability for the collection of meteorological data for target acquisition and improved sound ranging accuracy. It also provides a completely objective approach to determine optimal meteorological weighting factors for "effective met" concept used in sound ranging calculations.

Another thrust, target area meteorology is being addressed by assessing the effects of atmospheric behavior on the dispersion of multimunitioned projectiles and of the transport and diffusion of smokes, gases, and chemical/radiative agents.

A munition-expenditure model (KWIK) is being developed to account for atmospheric transport, diffusion, humidity, visibility, and terrain effects on the effectiveness of smoke munitions. Theoretical results of KWIK indicate significantly reduced munitions may be required if these atmospheric parameters are more fully accounted for. Evaluative field tests were conducted during FY 1980.

ATMOSPHERIC SENSING

The main purpose of Army research involved in the sensing and probing of the atmosphere is to determine the atmospheric effects on the performance of battlefield systems. This includes existing, prototype and future weapon guidance systems, remote atmospheric sensing systems, and high-energy laser (HEL) systems.

New atmospheric sensing techniques can increase the combat effectiveness of weapons and operations. The recent developments in remote sensing technology are being exploited to measure atmospheric parameters which reduce weapon system effectiveness. For the first time, measurements can be used for direct fire weapons such as on the main battle tank. A prototype 10.6-micrometer crosswind sensor for tanks is being developed to correct wind aiming errors along a gun trajectory in combat engagements involving tanks. The sensor will be a subsystem of the tank fire control system, and exploratory hardware development will be completed in FY81.

Army personnel, who will use future weapon systems such as COPPERHEAD, have no adequate means for objectively measuring ceiling and visibility. During 1980, a prototype ceiling-visibility sensor, the visioceilometer, will be fabricated. This hand-held sensor is designed to provide high-resolution ceiling and visibility information in a real-time mode and was based on the AN/GVS-5 laser rangefinder. The visioceilometer can be used at forward area aircraft landing sites, in support of E-O precision guided munitions, and other tactical systems where cloud height and visibility must be quantified. In FY81, tests of the visioceilometer in a variety of weather conditions will be conducted and improvements made in the analysis of lidar returns to allow more accurate measurements in smoke, dust, rain, and other aerosols.

New atmospheric sensing techniques and instrumentation have been developed for characterization of the National High Energy Laser Test Range (NHELTR) and for effective E-O system operation. Short and Long path scintillometers have been fielded to measure the path integrated optical turbulence (C^2_N). Fast response spatial temperature probes have been standardized for measurement of the microtemperature structure function. An optical technique using a star path analysis has been developed to measure the path integrated vertical modulation transfer function both night and day. Solar measurements of the optical spectrum using a Fourier Transform Spectrometer and controlled environment measurements of the pressure and temperature dependence of the water vapor continum absorption are used to characterize gaseous absorption for field operations. In situ spectrophone systems have been developed to measure aerosol absorption/extinction. These state-of-the-art techniques and instrumentation have significantly improved predictive model capabilities for use in field testing of E-O systems.

Acquisition of Weather Data in a Battle Area

A combat team taking wind observations (PIBAL or pilot balloon) in a data-sparse area. The illustration depicts a battle area.

Tests in support of the High Energy Laser Systems Test Facility (HELSTF) and for E-O atmospheric characterization field experiments required development of a remotely piloted, maneuverable, versatile, and economical airborne instrumentation platform. Two remotely piloted maneuverable atmospheric probe (MAP) vehicles have been developed to gather microscale meteorological data; atmospheric composition; turbulence data; and dust cloud particulate size, number, density, and composition.

These probes were utilized for atmospheric characterization of the North Oscura Peak (NOP) HELSTF, located at the north end of WSMR, NM, on top of a 8000-foot mountain peak, in June 1980. Meteorological data, atmospheric electric field intensities, and natural aerosol samples were successfully acquired with the MAP in beyond-the-cliff spatial extents which are otherwise inaccessible.

TACTICAL WEATHER INTELLIGENCE (TWI)

This program develops near real-time battlefield tactical weather intelligence-interpreted weather effects for the Army commander. The main thrust is to provide the commander with details of the effects of weather on his operations and his systems, weapons or surveillance, on a scale which is meaningful to his operation and is in a format which can be quickly assimilated. This information will be provided through the use of battlefield automated processing, dissemination and display systems. These processes will utilize weather, dust, smoke models, displays, and include the effects of complex terrain.

During FY80, efforts were continued to improve the description of the characteristics of smoke and dust in a battlefield environment through a probabilistic approach to transport and diffusion. Progress was made in the development of a technique involving pseudoparticles undergoing semi-random movements, conditioned by statistical parameters derived from terrain and atmospheric conditions. An extension of the method was made to include the ability to characterize heated sources of smoke. Results to date indicate that under many conditions the transport of smoke and dust by terrain-influenced wind fields is of greater importance than diffusion in describing concentrations over small areas.

ATMOSPHERIC EFFECTS ON HFDF/COMMUNICATIONS

This effort addresses atmospheric and ionospheric variability and irregularity by improving High Frequency Direction Finding (HFDF) reliability and accuracy through modeling ionosphere tilt, behavior, and small-scale irregularities using theory and field data. Millimeter wave communication reliability and capability improvements will be investigated through models and field experiments.

METEOROLOGICAL SUPPORT ACTIVITIES

Meteorological support to Army RDTE activities provided through the combined efforts of both civilian and Army meteorologists, observers and technicians. The mission of providing timely and accurate atmospheric data is accomplished by the deployment of 12 permanent meteorological teams, 10 located in the contiguous states and one each in Alaska and the Republic of Panama.

The measurements provided to the various users encompass the entire spectrum of atmospheric scales; i.e., micrometeorological measurements of mechanical and thermal turbulence in the surface boundary layer to macro-scale stratosphere. Types of measurements include the more familiar ones of temperature, relative humidity, pressure, solar radiation, and winds to more sophisticated measurements of optical turbulence, E-O measurements relating to "seeability", and remote measurements of winds along an integrated path.

A partial list of Department of Army projects being supported includes Multiple Launch Rocket System, ROLAND, STINGER, XM-1 TANK, Advanced Attack Helicopter, SLUFAE, Copperhead, Global Positioning System, HEL, and many major tests of various projectiles, fuzes and tubes. Other support includes environmental/exposure tests of system electronic components, clothing, personal equipment, weaponry, and various types of construction materials. The Army is currently undertaking a major program of modernizing the equipment used for data collection in order to support these advanced systems.

Army operations have always been affected by the atmosphere in which they must be accomplished, but never so extensively or critically as today's operations using modern weapon systems. With emphasis on more sophisticated sensors, fire-control systems, and weather intelligence requirements, the annual research investment by the Army is of increasing importance and will provide the necessary products to cope with fluid battlefields on a worldwide basis.

UNITED STATES NAVY

The Federal Plan for fiscal years 1980 and 1981 reported significant changes in the organization of the Naval Oceanography Command. These changes were designed to provide optimum meteorological, oceanographic, and mapping, charting and geodesy services to support the fleet and shore establishment. The Naval Oceanographic and Meteorological Support System (NOMSS) is organized to provide global analysis and forecasting services to the operating forces of the Navy and DOD. The mission of the NOMSS, as derived from Article 0316, Navy Regulations, 1973, is to insure that Department of the Navy meteorological requirements and Department of Defense oceanographic requirements are met. Emphasis will be placed on meteorology and the tactical orientation of most products. An equal and simultaneous effort is being directed in oceanography.

The NOMSS is primarily supported by activities and detachments assigned to the Naval Oceanography Command (NAVOCEANCOM) supplemented by shipboard environmental units, geophysics personnel (including enlisted meteorological) assigned to various staffs. U.S. Marine Corps Aviation Weather Units and environmental units are assigned to test stations, ranges, and the Naval Support Force Antarctica. In addition, research, development, and logistics support is provided by the various Naval Systems Commands, Navy Laboratories, and the Navy Environmental Prediction Research Facility.

Shore field activities within the NAVOCEANCOM having, inter-alia, meteorological responsibilities include two primary centers; the Fleet Numerical Oceanography Center (FLENUMOCEANCEN) and the Naval Oceanographic Office (NAVOCEANO); three Naval Oceanography Centers; two Naval Oceanography Command Centers; three Naval Oceanography Command Facilities; and 48 Naval Oceanography Command Detachments.

The FLENUMOCEANCEN, MONTEREY, CA, is the master computer center of the NOMSS and is the hub of the Naval Environmental Data Network (NEDN). Designed for product distribution, the NEDN is linked with the data collection networks of the U.S. Air Force and NOAA and receives world-wide coverage of original data. From these data, basic and applied numerical products are generated by FLENUMOCEANCEN for use of the NOMSS in producing specific support products and services.

Although NAVOCEANO's primary functions involve hydrographic and oceanographic surveys, it has been assigned significant meteorological responsibilities. These responsibilities entail the provision of aviation meteorological services at training and Naval Reserve air stations, the maintenance and repair of Navy meteorological observation equipment worldwide, and certain meteorological training management tasks.

The three Naval Oceanography Centers: The Naval Western Oceanography Center (NAVWESTOCEANCEN) at Pearl Harbor, HI; the Naval Eastern Oceanography Center (NAVEASTOCEANCEN) at Norfolk, VA; and the Naval Polar Oceanography Center (NAVPOLAROCEANCEN) at Suitland, MD; have been assigned broad geographical areas of responsibility for oceanographic and meteorological fleet support services and related matters. NAVWESTOCEANCEN is responsible for the Pacific and Indian Ocean areas; NAVEASTOCEANCEN for the Atlantic and Mediterranean Sea areas; and, NAVPOLAROCEANCEN for the Arctic and Antarctic areas. Utilizing basic and applied numerical products from the FLENUMOCEANCEN, environmental broadcasts and tailored support are provided in response to specific requests by the operating forces. NAVPOLAROCEANCEN also supports and operates the Navy/NOAA Joint Ice Center which prepares analyses and forecasts of sea ice conditions to the civilian community as well as the DOD. The geographic areas of responsibility are shown in the illustration that follows.

The two Naval Oceanography Command Centers (NAVOCEANCOMCEN's) are located at Rota, Spain, and on the island of Guam. NAVOCEANCOMCEN Guam assists NAVWESTOCEANCEN in the provision of environmental services in the western Pacific and the Indian Ocean areas. NAVOCEANCOMCEN Rota assists NAVEASTOCEANCEN in the Mediterranean Sea area. Both centers utilize the basic and applied numerical products from the FLENUMOCEANCEN to provide fleet environmental broadcasts and tailored support in response to specific requests by the operating forces. NAVOCEANCOMCEN Guam has an additional responsibility for the operation of a "Joint Typhoon Warning Center" (with the Air Weather Service of the U.S. Air Force) for the provision of tropical warnings in the western Pacific and Indian Oceans.

The three Naval Oceanography Command Facilities (NAVOCEANCOMFAC) at Jacksonville, FL, San Diego, CA, and Yokosuka, Japan, provide limited area (as individually assigned), local, and aviation environmental forecast services. Those in the contiguous states utilize basic and applied numerical products provided by both the National Meteorological Center and FLENUMOCEANCEN; the Yokosuka facility utilizes such information from the FLENUMOCEANCEN only. All three command assigned Detachments.

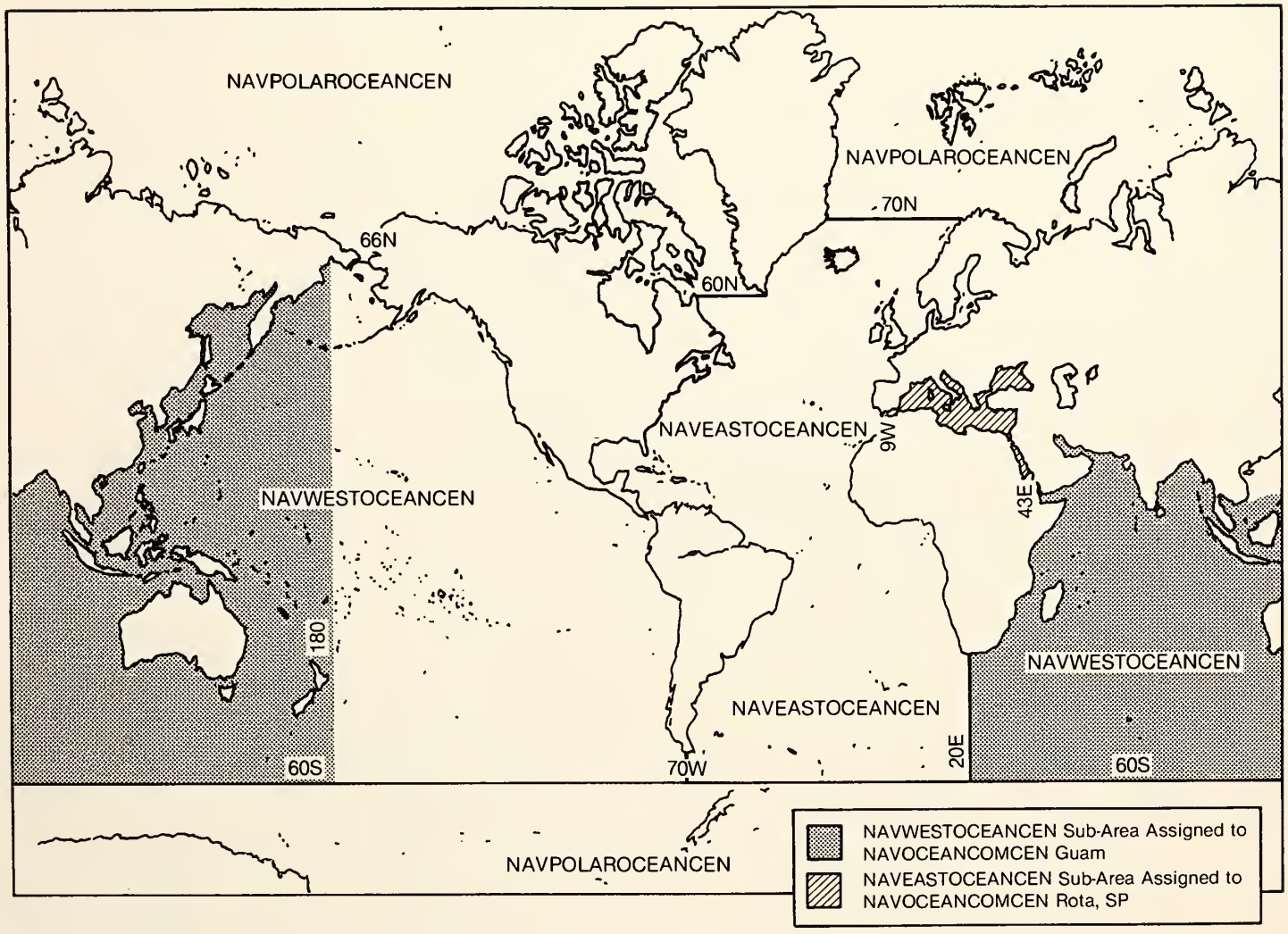


Figure 11-5. Navoceancom Areas of Responsibility for Environmental Services.

There are 48 Naval Oceanography Command Detachments (NAVOCEANCOMDETs) principally located at Naval Air Stations. Each detachment is established under an Officer in Charge or Chief Petty Officer in Charge who reports to a designated shore/field activity. Most of those detachments are oriented to provide direct environmental support, including aviation and oceanographic services, within their local areas. Those within the contiguous states utilize the basic and applied numerical products from both the National Meteorological Center and the FLENUMOCEANCEN to provide aviation meteorological and oceanographic services; normally only products from the FLENUMOCEANCEN are utilized to provide such services by detachments overseas. Three of the detachments are oriented to provide specific technical support to the NOMSS. This includes such functions as coordination of the Navy's climatological program at the National Climatic Center and liaison and coordination at U.S. Air Force bases for the interservice exchange of data and products.

During the period of this report, the new organization has functioned well and has met Navy and DOD needs. Consequently, emphasis is now being placed on details which will improve service further. This involves new and ongoing programs concerning training, improved services to aviation, the Naval Environmental Display Station (NEDS), and an updated central computing facility. To adequately satisfy requirements for analyzing and forecasting the air/ocean environment, emphasis is being placed on cross-training former meteorology and oceanography specialists. A Geophysics Technical Readiness Laboratory has been established to provide the opportunity for geophysics officers to become more aware of fleet operational needs which they support. Also, greater attention is being given to ensure that the training of Aerographer's Mates (enlisted personnel) meets the increasingly sophisticated requirements of operational support.

The Navy training program for both enlisted personnel and officers continues to stress the effect of the maritime environment on fleet operations in each of the world's oceans. This interest reflects, in turn, the increasing sophistication of the Navy's ships, submarines, and aircraft, their weapons and sensor systems, and command and control systems; all of which are sensitive to the composite air-ocean environment.

A recent development to improve services to Naval Aviation is the Optimum Path Aircraft Routing System (OPARS). The OPARS is a computer flight planning system designed, developed, and implemented by the Fleet Numerical Oceanography Center (FLENUMOCEANCEN) to provide flight planning support to Naval Aviation. It was developed specifically to support the Navy's mission of Anti-Submarine Warfare (ASW) and flights to and from ships operating at sea. OPARS optimizes aircraft flight paths to achieve fuel efficiency and reduce flight time. The system uses the Navy global environmental data base and will support all types of Navy aircraft.

Navy Environmental Display Station (NEDS) units are currently operating at the Fleet Numerical Oceanography Center Monterey; the Naval Eastern, Western, and Polar Oceanography Centers at Norfolk, VA, Pearl Harbor, HI, and Suitland, MD, respectively; the Naval Oceanography Command Centers at Rota, Spain, and Guam; and in the National Military Command Center in the Pentagon. Ancillary

model installations are planned for 1981/1982 in NAVOCEANCOM activities (primarily Detachments) having forecast responsibilities. The total program should become fully operational ashore in the next two years. The primary function of the NEDS is transmission receipt, storage, manipulation and display of graphic, alphanumeric and satellite data. NEDS capabilities include the multi-colored visual display of environmental parameters that significantly improve the ability to evaluate and forecast air-ocean environmental conditions of tactical significance to the operating forces. The NEDS is compatible with the Air Force automated COMEDS system and efforts are being made to provide for compatibility with the National Weather Service (NWS) AFOS system. This compatibility will facilitate the existing exchange of data, products, and services.

The Satellite Data Processing Center (SPC) is an operational computer facility within the FLENUMOCEANCEN Monterey, CA, designed to process data from the Department of Defense satellites and selected national environmental satellite systems to meet Navy requirements. Satellite information is invaluable in data sparse ocean areas.

Plans call for the upgrading of the primary computer system at the FLENUMOCEANCEN with the installation of a CDC CYBER 203 computer system. This will permit generation of the sophisticated air-ocean environmental products and tactical indices needed to support the increasingly complex weapon and sensor systems that are being introduced into the fleet.

The research in atmospheric sciences in the Navy is an integrated program of observation and description of atmospheric processes aimed at achieving a better fundamental understanding of those processes. The program includes work in solar physics to provide information on the ionizing radiation that enters the upper atmosphere to form the ionosphere and the ozone layer. These efforts in turn support the study of the aeronomy of the upper atmosphere and lead eventually to studies in the possible coupling of solar events to terrestrial weather. Tropospheric investigations in the program are oriented toward studies of ocean weather and include general studies of cloud physics, marine boundary layer processes, severe storms, remote sensing of the oceanic atmosphere, and atmospheric electricity. The approach to these studies is through experimental and theoretical investigations carried out through in-house and contract research with both universities and industry.

Navy environmental research and development efforts include the following fleet support oriented programs.

Tactical Environmental Support System (TESS)

The Tactical Environmental Support System (TESS) is a low risk system development integrating a variety of environmental modules. Using current technology, this project consolidates acoustic, electro-magnetic, and electro-optical forecasting systems for display on an interactive device (shipboard NEDS). The TESS will process environmental data received via ship-to-shore communications, local observations, and on board data storage. Initial operating capability is planned for FY 85-87. The first installations will be in large combatant ships to be followed by certain shore command and control centers.

Remote Ocean-Surface Measuring System (ROMS)

The ROMS effort will develop and demonstrate a capability to measure and process ocean surface parameters from an operational satellite and ground processing system to achieve the requirements for Satellite Measuring of Oceanographic Parameters. The project will provide technology options to either integrate oceanographic sensors into Defense Meteorological Satellite Program (DMSP) satellites by the mid-1980's utilizing the Satellite Processing Center at the FLENUMOCEANCEN, or participating in an interagency development of a National Oceanic Satellite System (NOSS).

Automated Environmental Prediction System (AEPS)

The AEPS program is developing an automated system to achieve a 1985 capability to provide essential environmental support requirements to Navy Command and Control. The system will process and analyze meteorological/ oceanographic data needed to describe air/ocean interactions to define environmental features affecting the naval operating areas around the globe; to predict atmospheric and oceanographic conditions that affect naval operations with the timeliness, accuracy, and scale of predictions necessary to meet command and control and weapons/sensor system requirements; and formulate, disseminate and display weapons/sensor systems performance predictions based on predicted environmental conditions. Emphasis is on analysis and prediction improvements. Testing of systems within this project will be accomplished independently and integrally.

Some of the features of the AEPS will be: Model Output Statistics (MOS) of winds, cloud cover, ceiling and visibility; steering and wind distribution statistics for tropical cyclones; a two-way interactive steering tropical cyclone model; an atmospheric global prediction system for the FLENUMOCEANCEN upgraded computer; a 3-D mesoscale model; a tropical cyclone strike probability; a dynamic sea ice model for the FLENUMOCEANCEN system; and a global oceanographic analysis and prediction capability.

Automated Environmental Prediction System II (AEPS II)

This project is developing an automated system to provide environmental predictions to Navy Command and Control and to the operating forces. Major emphasis is directed toward improvement in product dissemination, internal computer integrity, consolidation of communication functions and interfaces with users. The effort also implements, tests, and evaluates new models and techniques which have transitioned from exploratory and advanced development. Improvements and extensions will be made to the functional use of Optimum Path Aircraft Routing System (OPARS), Naval Environmental Ship Advisory Capability (NESAC), and the Naval Environmental Display Station-1 (NEDS-1). This includes a servicing capability for tactical aircraft and ships as well as enhancements to the capabilities of NEDS-1 by implementing software routines for graphics display and user flexibility for products received from the Primary Environmental Prediction System at Monterey, CA. Effort will continue to provide the environmental data user with products tailored to specific user needs.

Satellite Data Processing Center (SPC)

This project will fulfill a requirement to receive and process data from Defense and national satellite systems to alleviate global maritime data scarcity. During FY 1982, emphasis will be to complete development of software to receive and process data from the DMSP satellite required by changes to sensors being flown in FY 1982. Additional development will be to process selected data from geostationary satellites in order to utilize these data as an input to the data base residing in the SPC. This will provide wind data and an additional source of sea surface temperature. The Navy will continue development of display and dissemination procedures for fleet users.

Meteorological Measuring System (MMS)

This system will correct an operational deficiency and develop an environmental measurement and display capability in support of command and control. MMS capability will enable: (1) measurement of on-scene environmental parameters needed to assess/predict the effect of the environment on weapon systems performance developed in TESS supporting airborne ASW, AEW, and ESM missions; (2) processing, communications, storage, and display of environmental data, derived products, and weapon systems performance parameters generated by AEPS. MMS includes: (1) E-2 Aircraft Microwave Refractometer (AMR), (2) P-3/S-3 Aircraft Dropsonde, (3) Shipborne Mini-Refractionsonde (Minisonde), (4) Shipborne/Airborne Remote Sensors, and (5) the family of Naval Environmental Display Stations (NEDS).

Navy Environmental Engineering Development Program

The engineering development model (EDM-1) for the AN/SMQ-11, operational environment satellite acquisition and display system, has been completed and has copied real-time DMSP data at the Naval Avionics Center, Indianapolis, IN. All major interfaces have been verified; the 2-times and 4-times picture enlargement along with gray scale enhancement have been verified as well. Completion of the technical and operational evaluation are planned for fiscal 1981. Approval for service use is planned for early FY 1982. Components of the AN/FPS-106 weather radar will be redesigned to improve performance, reliability, and maintainability, and to extend service life of the system into the late 1980's. In FY 1981, improvements in the AN/FPS-106 will continue with completion of the redesigned solid-state circuits of the receiver/transmitter.

METEOROLOGICAL SERVICES

The Air Weather Service (AWS) of the Military Airlift Command (MAC) is tasked by Air Force Regulation (AFR) 23-31 to provide environmental services to the United States Air Force and Army. Its primary mission is to support the Air Force and Army combat operations in wartime. During peacetime, AWS prepares for its wartime role by practicing special wartime support procedures and by providing or arranging daily staff and operational weather support to its military customers. AFR 23-31 also defines certain related environmental and scientific support requirements to other DOD and U.S. Government agencies. Collection, processing, and dissemination of atmospheric and space environmental data and weather modification are intrinsic to such support.

The Bureau of the Budget Circular A-62, 13 November 1963, divides meteorological services into two types, basic and specialized. Although involved in both services, AWS is strongly oriented toward specialized services.

The general functions involved in providing meteorological services include observing current weather, communicating weather data and information, preparing analyses and forecasts, issuing and disseminating warnings and forecasts, and archiving weather information for ready retrieval.

The first of these functions, observing, comprises four programs: surface, upper air, radar, and meteorological satellites. Surface observations are taken by AWS personnel in support of analysis and forecasting, but primarily for other specialized applications. Observations at both Air Force and Army locations (fixed and tactical) are manually obtained, some atmospheric elements being sensed by instruments and some directly by the observer. The observations are made available locally and are collected by the Automated Weather Network (AWN), a high-speed communications network, for transmission to the Air Force Global Weather Central (AFGWC), as well as to other military and civil locations worldwide. In FY 1981, there were 108 AWS surface observing facilities or locations in the continental United States (CONUS) and 67 overseas.

Upper air observations provide the major input for numerical analysis and forecasting. Most of this information is obtained from U.S. civil and foreign sources as well as rawinsonde (fixed and mobile) and rocketsonde facilities operated by AWS. Additional upper air information from data-void areas is obtained from U.S. Air Force weather reconnaissance aircraft and in-flight pilot reports from both military and civil aircraft.

The Air Force performs aerial weather reconnaissance in support of U.S. military and national requirements. Thirteen WC-130 aircraft are provided by MAC's Aerospace Rescue and Recoivery Service (ARRS) and seven by the Air Force Reserve (AFRES). Aerial reconnaissance weather officers and dropsonde operators are provided by AWS (for the ARRS aircraft) and the AFRES (for the AFRES aircraft).

The weather radar is a principal source of information for making short-term warnings of severe weather. AWS operates 92 weather radar sets (18

overseas). Two of the Continental U.S. (CONUS) sets are a part of the U.S. basic weather radar network; 11 are used in a backup capacity. Eleven of the AWS weather radars are used to support the National Hurricane Operations Plan.

The final observing program is the meteorological satellite. The Defense Meteorological Satellite Program (DMSP) is an operational satellite system, managed by the Air Force for DOD, to support military requirements worldwide. The DMSP was designed and developed under a total system concept to provide the specialized meteorological data required by DOD. Sensors, communications, and ground processing facilities were developed to provide maximum responsiveness to the military decision-maker. The DMSP normally consists of two satellites in an approximately 830-km, sun-synchronous polar orbit with a period of 101 minutes. The DMSP provides visual and infrared (IR) images of the entire globe, plus temperatures and moisture soundings, auroral electron counts, and other specialized meteorological data to the AFGWC. It also supplies direct, real-time readout of regional cloud-cover information (visual and IR) to selected military terminals located around the world.

The present DMSP spacecraft series (Block 5D) uses an operational line-scan system (OLS). The OLS is a digital system designed to format and store visual and IR data. The visual sensors detect the brightness of reflected solar illumination from 0.4 to 1.1 micrometers. The IR sensors measure emitted radiation in the 8 to 13 micrometer spectral band. Beginning with the fourth Block 5D series spacecraft, the infrared spectral window was narrowed to 10.5 to 12.5 micrometers to reduce the amount of absorption by ozone and water vapor. The visual sensors were selected to optimize distinction among clouds, ground, and water. Electronic circuitry converts the sensed infrared energy directly into equivalent blackbody temperature, making temperature the displayed parameter. IR and visual imagery are obtained at near-constant cross-track resolutions of 0.5 km (fine data) and 2.8 km (smooth data). The Block 5D satellite incorporates selective redundancy and other reliability improvements to achieve longer operational life. It uses both stellar and inertial references, together with on-board processors, to maintain stability and pointing accuracy, and is significantly better than earlier DMSP satellites.

The DMSP communications and ground processing systems are designed to produce usable products within five minutes after the data stream ends. The central processing facility at the AFGWC is linked to the DMSP command readout facilities via a real-time satellite link. High-quality imagery is displayed for manual use and can be input directly into the AFGWC computers. There, it is converted into cloud parameters and collated with conventional meteorological data to produce a comprehensive three-dimensional numerical cloud analysis. The Air Force system for direct, local readout of DMSP data is a self-contained, air-transportable unit, capable of worldwide deployment in a matter of hours.

The usefulness of these observations of meteorological elements depends on an effective communications network. The USAF global weather communications system provides for the collection of meteorological data (alphanumeric and pictorial), delivers these data to weather centrals and forecast facilities, and distributes centrally-produced products to the user. Conventional weather teletype networks; high-speed automated digital facilities; long-haul, point-to-point teletype data circuits; facsimile networks; and radio and teletype intercept facilities constitute the Air Force Communications Command (AFCC) system.

USAF Satellite Data Handling System Console

Mockup of a Satellite Data Handling System (SDHS) console. Six of these consoles will be installed at AFGWC initially in 1981, with options for 29 more through 1983. The consoles and support equipment will fully automate the worldwide weather support operations of AFGWC. The console shown here contains three high-resolution CRTs for displaying imagery and one color alphanumeric CRT for display of tabular and graphical data. Computer support will be provided by a Harris 550 minicomputer.

The Automated Weather Network (AWN) is the backbone of military weather communications, using high-speed computers interconnected with 2400-4800 baud circuitry to deliver foreign and domestic weather data to designated users. Data-intercept sites in key overseas areas obtain foreign weather broadcasts for AWN delivery to the AFGWC. The USAF AWN also delivers these data to the Navy's Fleet Numerical Oceanography Center and to NOAA's National Meteorological Center. Overseas collection and dissemination teletype networks are driven by the AWN Automatic Digital Weather Switch (ADWS) computers. The CONUS ADWS at Carswell AFB, TX, drives the CONUS Meteorological Data System (COMEDS) and special teletype systems within the CONUS, an integral part of the weather collection and dissemination function. COMEDS serves as the prime communications system for the collection and dissemination of military Notice to Airmen (NOTAM) message traffic to all DOD users.

The Weather Facsimile Switching Center (WFSC) at Offutt AFB, NE, is the hub of the facsimile system, providing graphic and pictorial data to worldwide military users. WFSC drives the separate networks serving the CONUS, Europe and the Pacific, using computers to store and forward required products.

Data requirements of AWS units worldwide are met through a combination of routine data delivery and an Automatic Response-to-Query (ARQ) system to satisfy their needs for mission-essential, non-routine weather data.

In addition to communications responsibilities, AFCC maintains the AWS meteorological equipment. The command also maintains the Air Force facilities of the Defense Meteorological Satellite Program. Organizational maintenance is funded through the host base; intermediate maintenance is funded by AFCC.

Many analysis and forecast requirements for Air Force and Army customers are met by the AFGWC at Offutt AFB, NE. The AFGWC employs over 700 scientists and technicians (military and civilian) and uses five computer systems. The computer-based operation of AFGWC uses a build-and-apply concept. Worldwide weather data are relayed to AFGWC via the high-speed AWN and blended with civil and military meteorological satellite data to construct a real-time, integrated environmental data base. Scientific computer programs further digest the data to construct models of the atmosphere and forecast its future behavior. Final tailoring of the data is accomplished for application to the specific problem of the decision-maker.

In the Federal Plan for Cooperative Backup Among Operational Processing Centers, AFGWC is designated as backup for the NWS AFOS system, NMC's computational center for commercial aviation wind forecasts, and NWS's facsimile networks. In addition, the National Severe Local Storms Operations Plan designates AFGWC as the backup for the NWS's National Severe Storms Forecast Center.

The USAF Environmental Technical Applications Center (USAFETAC), Scott AFB, IL, provides environmental data to support the U.S. Air Force, U.S. Army, and other Government agency requirements for assessments of natural environmental effects on military plans, weapon systems, facilities, and intelligence activities. USAFETAC collects environmental data from its parent organization (AFGWC), then sorts, checks, and stores these data. USAFETAC operates a facility collocated with the National Climatic Center in Asheville, NC, for the exchange of climatic data with civil agencies. USAFETAC typically stores

worldwide weather observations, surface weather analyses, upper atmosphere analyses, and unique three-dimensional cloud analyses extracted from meteorological satellite imagery. From these stored data, it provides standard climatological products such as atmospheric profiles, soil moisture assessments, and probabilties of cloud-free line-of-sight.

AWS contributes to the unique global needs of military aviation and makes its information available to civil aviation. It provides pre-mission briefings and air-ground radio services, tailoring its observations, forecasts, and warnings for unique military aircraft requirements.

An aspect of special emphasis in military weather support is the need to provide adequate decision-assistance to commanders and resource managers. To fulfill this requirement, designated AWS personnel serve as part of the working staff of supported Air Force and Army units. In this capacity, it identifies all weather-sensitive areas of the supported operation, monitors the weather service provided in these areas, and provides expert advice when weather threatens to restrict training or combat operations. This AWS effort helps insure that Air Force and Army units are able to fulfill their missions in spite of adverse weather, and it results in efficient use of weather resources by gearing them to mission-essential support needs.

The Air Force and Army require worldwide meteorological services to support specific operational and planning activities. Military users require meteorological information directed to the needs of weapon systems being developed or used; command and control systems; Army firing units; research, development and evaluation; training and deployment of military forces; and contingency operations.

To provide these services, AWS maintains analysis and forecasting facilities in the United States and abroad, including the AFGWC in the U.S. and tactical forecast units in Europe and Alaska. Special centers, such as USAFETAC and the Joint Typhoon Warning Center on Guam, also fulfill unique military meteorological requirements. Similarly, AWS observing facilities obtain data in direct support of special military operations.

Aerial weather reconnaissance plays a vital role in specific military operations. Essential weather observations from tropical cyclones, along tactical deployment routes, from in-flight refueling areas and from missile and satellite recovery areas, are obtained by weather reconnaissance aircraft. In addition, these aircraft provide supplemental vertical soundings over data-sparse ocean areas.

AWS, through AFGWC, directly supports DOD Special Strategic Programs, the National Command Authority, the National Military Command System, and the National Security Agency. Tailored environmental support products are disseminated to these customers worldwide.

In support of tactical military operations, AWS support is designed around three basic components: the Centralized Production Units (CPUs), Tactical Forecasts Units (TFUs), and Weather Teams (WETMs). The CPUs consist of the Air Force Global Weather Central (AFGWC), the United States Air Force Evironmental Technical Applications Center (USAFETAC), and the Automated Weather

Network (AWN). The CPUs provide direct, mission-tailored support through designated communications circuitry, including the AWN, to TFUs and WETMs. The TFU represents a vital capability of the weather support force; it provides tailored weather service to in-theater decision-makers. These units provide forecast services and products for combat activities in a specific geographical area, tactical operation, or exercise, through relay of CPU products, tailoring of operational support products, and local generation of mission support products. WETMs are the basic units supporting customers in a tactical theater. They provide surface and upper air observing, briefing, and limited forecasting support. Tactical weather equipment (TACMET) is being developed to provide weather data to the TFUs and WETMs. Main components of TACMET will be the Tactical Weather System (TWS), tactical weather radar (AN/TPS-68), tactical meteorological satellite direct readout terminals (Mark IV), and tactical observing kits (TMQ-22 and Belt Weather Kits). Development of a communication broadcast system linking the TACMET, TFUs and WETMs is under study. Main components of the broadcast system will be reliable, secure, tactically deployable send and receive teletypes, receive facsimile sets, broadcast stations.

AWS integrates Army weather support into its overall support concept. AWS personnel are trained and oriented on applicable Army organizations, concepts of operations, and weather sensitivities required to satisfy Army environmental requirements. AWS support units are aligned and integrated with the Army intelligence organization. Support products are in a form which is directly usable and understandable by Army personnel, and are integrated into Army communications systems. Mobile and fixed meteorological equipment for use in Army support is programmed by AWS. In a tactical environment, direct forecast support is normally provided down to division level, to armored cavalry regiments, to separate brigade headquarters, and to special forces groups. Observer support is normally provided at these levels and at brigade levels within the division.

AWS provides meteorological support to the nation's space and missile programs. This includes a wide range of weather observing services at the Air Force Eastern Space and Missile Center and the Kennedy Space Center. AWS also provides the forecasting service for NASA's unmanned launches at the Kennedy Center.

AWS provides specialized meteorological services for the Air Force Western Space and Missile Center at Vandenberg AFB, CA, and the Pacific Missile Range which includes Pt. Mugu and San Nicholas Island, CA, and Barking Sands, HI. AWS also supports the White Sands Missile Range, NM, the Kwajalein Missile Range, and other DOD research and test facilities.

USAF and Army operational requirements for environmental support are the basis for all AWS actions to improve existing or acquire new capabilities. AWS assesses these requirements and attempts to satisfy them through either hardware acquisitions or technique development.

AWS plans to modernize its base-level weather support systems. This includes an Automated Weather Distribution System (AWDS) and an Advanced Weather Radar (AWR). Both have limited R&D funding budgeted during the period of the plan.

AWDS will perform two major functions, automated surface observing and data-handling. It will incorporate the latest state-of-the-art data processing, communications, and display technologies. The observing function will take, display, and transmit (long-line and locally) surface weather observations. The Federal Coordinator is exploring the feasibility of joint development and acquisition of the observing component by several Federal agencies. The data-handling function will maximize forecaster capability. A modular design will permit AWDS to be operated in a fixed or mobile environment and minimize staffing requirements. Initial installation is planned for late 1985 with completion of overseas and tactical installations by 1989. AWDS will be able to receive information from the National and Navy weather service systems.

AWR is being procured under the auspices of the Next Generation Weather Radar (NEXRAD) Joint System Program Office. NEXRAD will be an automated, digitized, S-band Doppler system that will be jointly developed, procured, operated, and maintained by the DOD, NOAA, and FAA within the CONUS and by the USAF overseas. The system will be designed to incorporate the latest technological advances in Doppler radar, data processing, communications, and display. The CONUS NEXRAD network will satisfy weather radar requirements in support of the general public, the military, and the entire spectrum of the aviation community. Installation of the NEXRAD is planned between 1986 and 1990.

FY 1981-82 funds have been requested to modify the current AWS AN/FPS-77 weather radars by replacing transmitter and receiver circuitry and antenna components. This action is needed to ensure continued logistics and maintenance support of ths radar until AWR is operational. The AN/TPS-68 tactical weather radar will be fielded in FY 1982 when shelter procurement is complete.

AWS, through the Air Force Logistics Command, has ongoing programs to upgrade its present weather reconnaissance capability by improving system reliability and maintainability. Prototype testing and replacement of components for the AN/AMQ-29 dropsonde recording system was completed in FY 1980 and is programmed for procurement in FY 1982. Improved weather reconnaissance and dropwindsonde capability is being considered, but funding has not been programmed for these systems. The feasibility of using off-the-shelf equipment and in-house development of these capabilities is under examination within the Air Force, in conjunction with NOAA, in an attempt to minimize costs.

The Air Force is modifying airfield meteorological equipment to replace obsolete vacuum tube components with solid-state electronics. These actions will materially reduce logistics and maintenance costs and increase equipment in-commission time. A $1 million contract was awarded in July 1978 for 344 modification kits to convert inventory transmissometers (AN/GMQ-10) to solid state circuitry. Delivery to AWS field units is expected to be completed in FY 1981.

In the area of atmospheric pressure measurement, the USAF has converted from wide-bore, mercurial barometers to dead-weight piston gauges used as regional primary pressure standards. Funds have been requested to procure a digital barometer and altimeter setting indicator. The unit will be solid state, easily transportable, highly accurate, and mercury free. This will eliminate base weather station mercurial barometers and their mercury contamination health hazard. In future years, the Air Force plans to replace its

temperature/dewpoint and wind-measuring equipment, and to upgrade its cloud-height measuring system and upper air (rawinsonde) receivers with solid state components.

A significant improvement in the interaction between man and machine to provide accurate and comprehensive meteorological forecasts is the planned acquisition in FY 1981 of an Interactive Processing and Display System (IPADS) for use at the AFGWC. In March 1979, a contract was awarded for the acquisition of a Satellite Data Handling System (SDHS) with an option for the acquisition of IPADS. The two complementary systems will provide computer consoles to be used by AFGWC weather technicians to interact directly with the AFGWC computers, thereby eliminating most physical handling of hardcopy information (plotting, overlaying, tracing, posting, sorting, etc.) through automation. Meteorological satellite imagery will be electronically integrated with conventional meteorological data to construct weather products.

SUPPORTING RESEARCH

The overall objective of the Air Force meteorological research program is the development of techniques and equipment for observing and predicting meteorological conditions that affect military operations. Requirements for research and technology in meteorology are expressed in Air Force Technology Planning Objectives, Research Objectives, Technology Needs, Statements of Operational Needs, and Development Goals. In addition, the Air Weather Service provides guidance in the form of geophysical requirements and research objectives. The Air Force Geophysics Laboratory has the mission responsibility within the Air Force to conduct basic research and exploratory development in the environmental sciences, including meteorology. Its program places emphasis on automated direct and remote sensing systems, weather satellite imagery analysis and application, short-range terminal forecasting and numerical prediction techniques, climatological studies, and cloud and precipitation physics. While predominantly conducted under contract, research and development for the Defense Meteorological Satellite Program is also described below.

In the area of weather radar and remote sensing, the principal effort is on the development of improved instrumentation, preferably automated, for the measurement, processing, display, and analysis of meteorological information. In FY 1981-82, advanced weather radar concepts will continue to be investigated to meet AWS's long-range requirements. The investigation into techniques for detection and warning of hazardous wind conditions over air bases will focus on the development of CO_2 laser systems. Microwave and electro-optical techniques for indirect sensing of aircraft turbulence, low-level winds, temperature, and humidity will be investigated.

Radar diagnostic techniques for the operational detection of significant features in storms indicative of their development, motion, and severity will be continued. In FY 1981-82, conventional radar and Doppler radar data will be analyzed to identify features of hail-producing storms. Coherent optical and microwave radar polarization diversity techniques will be developed for possible use in measuring number concentration, size distribution, phase, and shape characteristics of cloud and precipitation particles that affect aircraft, missile, electro-optical, and communications systems. Algorithms will be developed to detect and predict gust fronts and associated low-level wind shear.

Automated, ground-based observing and short-range forecasting will continue to be major efforts in FY 1981-82 with the continued development of a computer-controlled meteorological sensing, processing, and display capability for use at fixed bases and mobile sensors to measure visibility and cloud height around tactical airfields. Automation of 0- to 3-hour forecasts of cloud base height and low-level wind shear will also be a goal. To further improve the quality of short-range forecasts, analysis and use of satellite imagery will be optimized. In 1981, at least one forecasting system based on satellite data will be tested. By FY 1982, research into improved cloud analysis methods will focus on special procedures which rely solely on satellite data. In a related effort directed toward improving satellite system technology, investigation of infrared and millimeter wave instrumentation and techniques for application to atmospheric sounding, together with theoretical studies of methods for temperature retrieval from IR radiance, will be extended.

There is a continuing requirement for specialized climatological information for use in the design or operation of military equipment. In FY 1981-82, models of space and time variations of atmospheric density, temperature, and wind for altitudes up to 90 km and Northern Hemisphere areas of probabilties of precipitation free lines-of-sight will be refined. In addition, theoretical models will be developed for use in determining the probability of favorable weather in all phases of military operation. In FY 1981-82, a global climatology of the probability of exceeding specific rainfall rates will be developed.

Beginning in FY 1981, the USAF will undertake a major advanced development program seeking to automate the observation, collection, and processing of weather information in enemy controlled or uncontrolled tactical battlefield areas and airspace. In FY 1981, the main emphasis will be on the development of humidity, visibility, and cloud cover sensors potentially usable in airborne measurement systems.

A new basic research effort was initiated in FY 1981 to improve the Air Force's capability in providing cloud forecasts on a global and regional scale. Integral to this objective is the development of a global dynamical model which will be formulated from a careful evaluation of the salient features of existing research and operational models. In FY 1982, emphasis will be placed on designing the structure of the global model, including procedures for matrix inversion, interpolation, filtering, and numerical quadrature procedures. Parameterization procedures for boundary layer processes and radiative properties of clouds and other constituents pertinent to cloud prediction will be initiated.

Research also will be conducted into the dynamical and microphysical processes present in the atmospheric melting layer. In FY 1981, studies of the precipitation processes from the snow growth region will be extended down into the melting layer. Instrumented aircraft flights will gather pertinent cloud physics data in and around the melting layer to validate and extend our basic understanding of the processes operating. In FY 1982, primary emphasis will be placed on the development of models of the microphysics and mesodynamics of the region incorporating features derived from detailed radar reflectivity measurements.

In addition to the research efforts described above, the Air Force Office of Scientific Research has established programs to take advantage of scientific capabilities within universities and commercial firms. This research is concerned with specifying, modeling, and predicting meteorological factors that may affect Air Force operations. In FY 1981-82, investigations in atmospheric electricity, cloud physics, aerosols, and medium-scale meteorological systems will be supported. The development of a sophisticated cloud physics chamber will permit theoretical experimentation into microphysical processes.

Regarding the Defense Meteorological Satellite Program, in FY 1981 the satellite development necessary for space shuttle compatibility and transition in FY 1986 will be continued, as will development of the microwave imager and development of ground segment encryption. System engineering and analysis efforts necessary to support launch and on-orbit operations will be provided in both FY 1981 and FY 1982.

In FY 1982, work will continue on design and development for transition of Block 5D2 spacecraft to shuttle launching in FY 1986. Funds will acquire a primary payload with some modifications for shuttle launching and will acquire advanced technology sensors. Development of a satellite simulation system and ground command and telemetry systems will be continued.

DEPARTMENT OF ENERGY

The Department of Energy (DOE) supports meteorological services at nine of the laboratories and at the Nevada Test Site. Services include climatological summaries, general weather forecasts, and items specifically in support of laboratory operations such as environmental monitoring, atmospheric sciences research, and hazardous material release assessments. The Weather Service Nuclear Support Office at the Nuclear Test Site provides continuing meteorological services required by the safety and technical programs associated with all forms of nuclear and non-nuclear experiments conducted at the test site and other locations.

DEPARTMENT OF INTERIOR

The principal meteorological activity of the Department of Interior (DOI) is the weather modification research program called Project Skywater, administered by the Water and Power Resources Service, dedicated to augmenting water resources in critical water problem areas of the West through the development and demonstration of a practical precipitation management technology. Other Water and Power activities, including runoff forecasting, flood hydrology, irrigation projects, and reservoir operations, as well as projects related to the development of wind and solar energy resources, also require the collection and use of meteorological data.

The Water Resources Division of the Geological Survey in DOI collects and uses meteorological data in its runoff forecasting flood hydrology activities and in studies of the effects of atmospheric deposition.

The Bureau of Land Management in DOI collects meteorological data from a system of remote automatic weather stations and operates a lightning detection system, containing wideband direction-finders that respond primarily to cloud-to-ground lightning, in its fire-management program.

DEPARTMENT OF STATE

The Department of State interests in meteorology are general but touch a number of areas. They involve the international aspects of food and feeding the world, disaster warnings and assistance, long-range concern with the socio-economic effects of climate change, World Meteorological Organization activities, and international programs such as the GARP Atmospheric Tropical Experiment (GATE), and concern with some programs which start as operating programs but develop international interest and concern such as the possibility of seeding of storms in the Pacific.

Project SKYWATER Observations Using Aircraft

The University of Wyoming King Air used in Project SKYWATER is capable of monitoring and recording more than 1,800 atmospheric variables each minute (Department of Interior).

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

The Federal Aviation Administration (FAA) is responsible for the safety and separation of aircraft and the efficiency of flight operations. The adequacy of aviation weather information contributes significantly toward fulfilling these responsibilities. FAA makes recommendations to the U.S. Department of Commerce on civil aviation meteorological services, provides specialized equipment and surface observations at certain airfields, distributes weather data over civil communications systems, and provides the principal means for disseminating weather information to pilots.

Weather information for pilots is made available through Flight Service Stations, recorded messages broadcast over navigational aids, special weather broadcasts, and telephone answering systems. Air Route Traffic Control Centers now have weather service units manned by NWS meteorologists to assure that vital weather information is available to the controllers.

FAA maintains a continuing research program to improve aviation weather service to the National Airspace System and its users. FAA also engages in engineering efforts to improve weather observations and communications related to aviation.

SUPPORTING RESEARCH AND DEVELOPMENT

The FAA continues to support development of the Next Generation Weather Radar (NEXRAD) with personnel and funding for the NEXRAD Joint System Program Office (JSPO). This support will assist the NEXRAD JSPO in the development of an integrated logistics plan, a personnel training program, and a systems development plan. Work on alternative NEXRAD designs, which was contracted for in FY 1981, will be completed and contracts to validate the design(s) selected will be awarded. Fabrication of a prototype NEXRAD system will begin by the end of 1982. In a NEXRAD-related but independent effort, the FAA will be testing optimum weather radar scan rate and signal processing algorithms at the National Severe Storms Laboratory (NSSL) in Norman, OK. In addition, at the FAA's Technical Center near Atlantic City, NJ, the assembly of a transportable weather radar test bed will be completed in 1982 for field test at selected airports.

Work on detection, tracing, and 0-30 minute prediction of convective cell movement and intensity will continue in FY 1982. Reflectivity and Doppler radar data collected in the spring of 1981 at NSSL will provide independent data sets upon which prediction algorithms will be tested for accuracy and reliability.

As part of the FAA's weather enhancements to the National Airspace System (NAS), the completion of a detailed design of the system concept description for the Aviation Weather System will be completed in FY 1982.

Other NAS enhancements include:

- In 1981, the FAA will complete staffing 21 FAA Air Route Traffic Control Centers with three NWS meteorologists at each center. They continue to provide a vital service to the FAA as part of the Center Weather Service Unit (CWSU) team. In FY 1982, efforts to improve the CWSU effectiveness

through automation of their work station will result in specifications for weather data processing and display within the control centers.

- To further support the enroute air traffic controller function, a test of the CWSU meteorologists ability to provide weather intelligence directly to the control positions via the Electronic Tabular Display System will begin in FY 1982. A similar program will begin the development cycle for terminal air traffic controller weather support in late 1982.

- Testing of the Discrete Address Beacon System Data Link will continue into the middle of the 1980's. One of the potential uses of the data link, which is being investigated in FY 1982, is the extraction of winds aloft information from test aircraft. The eventual use of these data would be to improve flight planning for more efficient aviation fuel consumption.

- With FAA support in FY 1980, NOAA established a joint system program, Prototype Regional Observing and Forecasting System (PROFS) at the Environmental Research Laboratories (ERL), NOAA, in Boulder, CO. One aspect of PROFS is a terminal area weather data acquisition and short time period forecast program. The program will utilize weather radar and terminal area meteorological sensors to provide much improved terminal area weather depiction for operational use by airport operators and the NAS. Field testing of the system components began in the summer of 1981, and the full system test is scheduled at Stapleton Airport, Denver, CO, during the summer of 1982.

During the past year, the FAA has made significant progress in the development of automated surface weather observation systems leading to a planned procurement in FY 1982 of a number of the basic--Wind, Altimeter, and Voice Equipment (WAVE)--systems.

The FAA, working with the NWS, will be testing an intermediate automated weather system, Automated Low-Cost Weather Observation Systm (ALWOS), at Dulles International Airport through FY 1982. The ALWOS system is modularly designed and is the next step up from the basic WAVE system. It will include measurement and reporting of cloud height, visibility, and precipitation.

Associated with the ALWOS development and tests, the FAA and the Air Force are evaluating several commercial models of visibility sensors at Otis AFB, MA. The FAA is also testing visibility and cloud height sensors at the Landing Aids Experimental Station at Arcata, CA. At Arcata, long baseline transmissiometers have been installed for use as one means of comparing the test sensors. The FAA also plans to initiate present weather sensor tests at Arcata during FY 1982.

FAA plans to automate 61 Flight Service Stations (FSSs) and ultimately consolidate the remaining FSSs into these 61 stations. Consolidation will be accomplished in several stages. After each automated FSS is operational, existing stations within its flight plan area are to be consolidated into the station only when (1) the quality of service provided by the automated station is equal or superior to the service available from the then-existing stations, and (2) a consolidation plan has been developed that is tailored to the needs of the flight plan area.

The initial level of automation will be the Model 1 system which will consist of a computer that will be a subset of the final system design for the automated FSSs. Fourteen Model 1 computer systems will be installed at selected Air Route Traffic Control Centers (ARTCCs) which will drive remote alphanumeric terminals at 41 of the busiest FSSs. The Model 1 software will be a relatively simple version that will permit automatic file updating, retrieval, display alphanumeric weather and aeronautical data, flight plan entry, and flight plan processing. Each computer system will have a dedicated data communications line from the FAA Weather Message Switching Center (WMSC) in Kansas City, MO, and the Automated Service B Data Interchange System (ASBDIS).

The upgraded or Model 2 automation system will provide full specialist automation capabilities. Twenty-three Model 2 computer systems will be installed to replace the Model 1 computer systems and drive the remoted specialist terminals at the 61 FSSs to be automated. The specialist terminals will display alphanumeric and graphic data to be furnished directly by two Aviation Weather Processors (AWPs). One at Salt Lake City, UT, and the other at Atlanta, GA. The AWPs will interface with the WMSC for alphanumeric data and with NWS's National Distribution Circuit (NDC) for graphic weather products. Weather radar data will be received from selected NWS/FAA radars and stored in each computer system for instant retrieval. This will provide the necessary automation capacity to meet forecast service demands through 1995 for FSS specialist operating positions and for self-briefing access features for pilots throughout the country. Details are given in the Master Plan for Flight Service Station Automation Program, January 1978, and the Master Plan Addendum, March 1980. Phase I of the FSS Automation Program will be completed in FY 1981. A single contractor was selected to accomplish Phase II of the program which provides for the production/installation of the Model 1 and 2 computer systems, two AWPs and the development of long-term enhancements to the Model 2 system, known as Model 3. In addition, transcribed weather broadcast route forecasts, local briefings, significant meteorological weather via telephone with touchtone capability will be added to the Voice Response System (VRS) under operational test in the Washington, DC, and Columbus, OH, areas.

In FY 1982, five Model 1 computer systems will be completed and 12 FSSs will receive remote alphanumeric terminals.

Other major R&D efforts in the FSS program are to develop techniques that will permit pilots to have direct access to the FSS automation data base. The approach is as follows:

- Continue development of computer-generated voice response capability to touchtone inputs, Voice Response System (VRS).
- Develop automated flight plan filing capability via telephone with touchtone or voice inputs.
- Integrate voice response/flight plan filing and Pilot Automatic Telephone Weather Service (PATWAS) into a national system designed for pilot self-briefing.
- Develop the concept of pilot self-briefing via interactive coupling of home television sets with the FSS automation data base.

- o Jointly develop, with NWS, new formats and techniques for generating, processing, and delivering aviation weather products to pilots for pre-flight and inflight applications.

METEOROLOGICAL SERVICES

Each Center Weather Service Unit in the 20 ARTCCs within the 48 contiguous states and the one in Alaska will have four NWS meteorologists by the end of FY 1981. They will provide service to the center's air traffic controllers and to other FAA facilities for two 8-hour shifts per day. FAA reimburses the NWS for the salaries of the meteorologists as well as providing end-year staffing positions from its resources.

To assist the meteorologists in the CWSUs, a radar remote weather display program was initiated in FY 1980. This system displays on a television screen six levels of precipitation intensity in six different colors, as detected by NWS. The program also includes a display for the enroute flight advisory service position in 44 of FAA's FSSs. The installation of equipment will be completed by mid-FY 1982.

The installation of the low-level wind shear alerting system is continuing and will be completed at approximately 100 airports by the end of FY 1982. This system uses wind sensors (anemometers) near the approach and departure ends of the runway and compares the readings from these sensors with a centerfield wind sensor. When a wind shear is apparent from this comparison, the tower controller is alerted and the information is passed from the controller to the pilot approaching the airport or preparing for takeoff.

Two corporations are under contract to FAA to produce an engineering model of a cloud height indicator system. These engineering models use the laser technology in measuring cloud height. A production contract is to be awarded to one of these contractors based on the best combination arising out of the proven performance of the engineering model systems. The production contract is expected to be awarded in FY 1981, and installation of the production system will be initiated in FY 1982. This cloud height indicator is a prime candidate for use in automated surface weather observing systems being developed jointly with the Departments of Commerce and Defense.

During FY 1982, FAA plans to install automated surface weather observing and reporting systems at some general aviation airports. These systems will give the pilot, via radio, the wind direction and speed as well as the altimeter setting. These are the Wind, Altimeter and Voice Equipment (WAVE) systems mentioned earlier. The airports are those not presently having any weather observing service but which do have an approved instrument approach from navigation aids. With this automated information, the pilot can safely make an instrument approach to the minimum altitude permitted allowing more efficient and safe use of the airport.

In addition to the WAVE system, FAA has taken the lead in the Joint Automated Weather Observing System (JAWOS). The JAWOS is to be developed and deployed jointly by the Departments of Commerce, Defense and Transportation to satisfy future weather observing requirements of these and other agencies. It is a joint program similar to the development and deployment of the Next Generation Weather Radar in which the NWS has the lead.

U.S. COAST GUARD

The U.S. Coast Guard cooperates with the NWS in observing, forwarding, and disseminating weather information. Observations taken by Coast Guard units and those from coastal and high seas commercial shipping are sent to NWS offices. Some NWS automated observing systems are located at Coast Guard stations and navigational buoys. NWS forecasts and warnings for coastal and high sea areas are included in the scheduled Coast Guard Marine Information Broadcasts.

Coast Guard personnel stationed at the NOAA Data Buoy Office at Bay St. Louis, MS, furnish technical support and liaison for NOAA Data Buoy operations. Coast Guard vessels are used to deploy and maintain NOAA data buoys.

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) is responsible for working with state and local government agencies to ensure adequate air quality meteorological support programs. Applied research and operational meteorological support support to EPA is provided by the Meteorology Laboratory of NOAA's Air Resources Laboratories. Such operational support to the Office of Air and Waste Management, the EPA Regional Offices, and other EPA components includes review of the meteorological aspects of environmental impact statements, state implementation plans, application of dispersion models, and preparation of dispersion studies and evaluations.

RESEARCH PROGRAM FOR FISCAL YEAR

EPA's applied research is in the areas of air quality dispersion model development, evaluation, verification, and application, development and application of air pollution climatology, determination and description of pollutant effects on atmospheric parameters, and determination of meteorological effects on air quality. Dispersion models for inert and reactive pollutants are under development and evaluation on all temporal and spatial scales. Particular emphasis is being given to the development of a dispersion model for use in complex terrain; and photochemical air quality dispersion models on several scales utilizing data collected during earlier field programs. These programs initiated, in FY 1980, are also prime research projects in FY 1982. Planetary and urban boundary layer models are under development for use with air quality dispersion models. Examination of the relationship between meteorology and air quality, with emphasis on ozone and sulfates, continues. The effects of air pollutants on atmospheric parameters, such as visibility and precipitation chemistry, are also under continuing investigation.

ENABLING LEGISLATION

- Clean Air Amendments of 1970 - Sections 103, 110, 303, 313
- Clean Air Amendments of 1977 - Sections 121, 126, 127, 128, 310

INTERAGENCY FUND TRANSFERS

Funds are transferred to the National Oceanic and Atmospheric Administration for the provision meteorological research and operational support of the agency's regulatory mission. Research activities define, describe and study the meteorological factors important to air pollution regulatory activities and the development of air quality standards and criteria. Air quality models are developed, evaluated, and validated for use by EPA in its regulatory and compliance activities. A users network for applied models of air pollution (UNAMAP), consisting of dispersion models either developed internally or by other groups and validated under the program, is maintained and continuously modified and expanded for use by the public and private sector. Direct operational support includes the review of the meteorological aspects of environmental impact statements, state implementation plans, and other compliance documentation; the application of dispersion models for control strategy evaluation; and the conduct of physical and mathematical dispersion studies for guideline and standard development, evaluation, and implementation.

FEDERAL EMERGENCY MANAGEMENT AGENCY

The Federal Emergency Management Agency (FEMA) was established in 1979, to merge closely allied Federal programs involved with preparedness, mitigation and response to national emergencies ranging from natural and man-made disasters to nuclear attack. FEMA replaces five former agencies, consolidating into a single structure a dozen different Federal emergency-related activities, including such functions as community-awareness programs for weather emergencies and coordination of all emergency warnings.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The National Aeronautics and Space Administration (NASA) Weather and Climate Program develops and applies space technology to improve the quality of meteorological information to meet national needs. NASA's role in this arena is based upon the belief that satellite-borne sensing systems can provide much of the required data more cost-effectively than by any other means. The NASA program includes the following major components.

- Development of space-borne observing capabilities and coordinated ground systems to detect, monitor, predict, and warn of severe storms.
- Development of space-borne observing techniques together with suitable data processing, analysis, and modeling to improve mid-range weather forecasting.
- Investigation of the potential of space-borne observing systems to detect, monitor, and predict climatic variations.

The goals of the NASA Weather and Climate Research Program are to observe and study the atmosphere and the Earth from the unique perspective of space in order to increase our understanding of the atmosphere and to improve our ability

to predict its future state. These goals are pursued through the development of: new sensors; new space and ground systems; new techniques to process, interpret, and verify satellite data; new analytical procedures; and advanced models to utilize the data diagnostically and prognostically. Programmatically, these supporting rsearch activities are managed under three elements as follows:

- o Development of space and ground systems for severe storm detection, monitoring, prediction, and warning.

- o Development of space and ground systems to improve our monitoring of global weather and our mid-range forecast capability (3-14 days).

- o Investigation of the potential of space technology for monitoring and predicting climate variability.

In the study of severe storms, NASA uses space, aircraft, and ground-based technology to obtain observations of severe storms in order to improve our understanding of the processes involved in their generation and propagation. Data processing, analysis, interpretation, and modeling of these observations of thunderstorms and tropical storms are performed to improve prediction capability. This research also leads to the specification and development of new space capabilities for the detection and monitoring of severe weather.

The NASA-developed VISSR Atmospheric Sounder (VAS) on the Geosynchronous Operational Environmental Satellite, GOES-4, was launched in September 1980, and is undergoing assessment to determine its value for severe storm observations. This instrument is providing temperature and moisture soundings in the vicinity of severe storms with unprecedented temporal and spatial sampling and is expected to have a significant positive impact on detecting and forecasting such phenomena.

There are numerous basic research and practical applications of the time and space variations of lightning discharge rate. These range from unlocking the secrets of global electrical behavior to estimating storm severity and tornado likelihood to obtaining accurate climatologies of lightning strike points for improved and more efficient lightning protection. NASA has been exploring space observing techniques that would permit observation of the majority of discharges, day or night, from geosynchronous altitude (36,000 km). Currently, a comprehensive set of absolute intensity and spectral observations are being conducted from ground-based laboratories and the U-2 high-altitude aircraft flying above the storms. The most promising technique considered to date is a differencing optical array that should be able to detect flashes by observations each millisecond.

NASA has sponsored a study on the use of satellite infrared data to observe and predict frost-freeze conditions. This project was designed to assist NWS freeze forecasters in Florida by providing half-hourly satellite temperature maps and projections which would help them to inform the fruit growers of impending lengthy freeze conditions. The system has been developed and tested over a number of years and now is nearly ready for transfer to NOAA. Final system evaluation should occur in the 1980-81 winter season.

A joint NASA/NOAA project called the Centralized Storm Information System (CSIS) will result in an improved forecasting capability at the National Severe Storms Forecast Center in Kansas City, MO. An interactive data collection, access, analysis and display system is being developed which will provide all forms of currently available meteorological data directly to video consoles in the forecast office. Satellite, radar, surface, and upper air data will be instantly accessible, along with NMC analyses, forecasts, and other forms of guidance. The data can be superimposed and interpreted using the same map areas and projects. Derived products can be superimposed on color-coded observations to provide a new dimension for the understanding of rapidly-developing weather situations.

NASA's basic role in the National Climate Program emphasizes applications of space technology to improve our understanding of the physical processes and interactions which control the Earth's climate and is essential to the development of a national climate forecasting capability.

Four principal areas in which research is being conducted by NASA in support of the national program are:

- o Data Base Development. To demonstrate and facilitate the use of space-acquired global data sets for climate applications and studies.

- o Special Studies. To conduct special studies to gain insight and understanding of the physical processes and connections between climate variables, to develop parameterizations for models, and to aid in future sensor development.

- o Climate Modeling and Analysis. To develop climate modeling capabilities to guide the design of the observing system, to optimize the utilization of space-acquired data, to carry out physical processes studies, and to help assess climate predictability.

- o Climate Observing System. To develop a climate space-observing system including operational system improvements, new instruments, and research satellites as needed, as part of an integrated system composed of complementary and mutually supporting elements.

NASA has been assigned lead responsibility for the National Climate Program's principal thrust in solar and earth radiation. The earth's radiation budget, which is the central element of this research, describes the energy balance whch exists between the sun, Earth, and space. It is the geographical and temporal imbalance in this key relationship which governs the state and changes of reginal climate. Earth radiation budget data acquired by Nimbus research satellites, beginning in 1976, are currently being processed and merged into a global climate data set, to be augmented with sounder data from the Earth Radiation Budget Experiment (ERBE) beginning in 1984. Monitoring of the solar irradiance is also being accomplished by sensors aboard Nimbus 7 and the Solar Maximum Mission (SMM). The total solar irradiance (often referred to as the solar constant) is the basic source of energy for driving the climate system. Climate models studies have shown that persistent variability in this quantity could have a major impact on climate.

NASA continues to supply NOAA with the TIROS-N series spacecraft (funded by NOAA) for operational meteorological deployment. The NOAA-B spacecraft, which was launched in late May 1980, failed to achieve a viable orbit because of a launch vehicle problem. TIROS-N and NOAA-6 continue to provide the required data although subsystem failures aboard TIROS-N have eliminated some redundancy thus prompting the preparation of NOAA-C for launch during the second quarter of 1981.

NASA is participating in the analysis of the data gathered during the GARP Global Weather Experiment. Emphasis will be placed on observations obtained from space with the interpretation and application of these data to the development of advanced techniques for modeling and prediction. The investigations involve both NASA scientists and those from the external scientific community.

In order to facilitate the growing requirements for data analysis and modeling in the NASA atmospheric research programs, procurement of an advanced vector processor has been initiated. This machine is expected to increase the present computing capability used for atmospheric research and development by a factor of ten.

NASA is conducting supporting research and development activities to improve our remote sensing capabilities for possible future deployment in satellites. Studies involve remote sensing of atmospheric temperature, pressure, moisture, and winds using passive and active techniques.

NATIONAL SCIENCE FOUNDATION

The National Science Founation (NSF) supports meteorological research primarily at universities and non-profit institutions through its Atmospheric Sciences Division. Although the research is largely basic in character, there are portions of three programs that could ultimately improve either basic or specialized meteorological services. The three programs are (1) Meteorology, (2) Experimental Meteorology and Weather Modification, and (3) the Global Atmospheric Research Program (GARP).

The Meteorology Program supports the development and improvement of limited area numerical models of the atmosphere that could ultimately improve operational numerical forecast models.

The Experimental Meteorology and Weather Modification Program, together with NASA, DOD, FAA, NOAA and DOI, supports university scientist participation in activities such as the Severe Environmental Storms and Mesoscale Experiment (SESAME) which is aimed at improving the predictions of severe weather.

GARP is an international effort to obtain basic knowledge that should ultimately improve weather forecasting. NSF supports research on methods of accounting for smaller scale processes in large-scale numerical models of the atmosphere that could directly improve operational weather prediction.

NUCLEAR REGULATORY COMMISSION

The Nuclear Regulatory Commission (NRC) licenses and regulates all nuclear facilities subject to the Atomic Energy Act of 1954, as amended. The licensing and operation of nuclear facilities require identification and evaluation of meteorological conditions that can affect the safe operation of the facility and that provide input to the assessment of the radiological impacts of any airborne releases from the facility.

Within the NRC, the Offices of Nuclear Reactor Regulation and Nuclear Material Safety and Safeguards review facility siting, design, construction, and operation. These reviews include consideration of meteorological factors. The Office of Inspection and Enforcement assures that conditions of NRC licenses are carried out and conducts NRC response to nuclear facility emergencies. The Office of Standards Development develops regulations, guides, criteria, and other standards relating to the protection of public health and safety and the environment in the licensing of nuclear facilities. The Office of Nuclear Regulatory Research develops and conducts research programs in support of activities of the other offices.

There are several meteorological areas which will require major emphasis during FY 1981 and beyond, and will involve the cooperative efforts of all of the NRC offices. Paleoclimatic site investigations of high-level radioactive waste depositories and the development of meteorological criteria for siting of low-level radioactive waste depositories are planned. Upgrading of the meteorological capabilities of the NRC and the operators of nuclear facilities are in process to cope with emergencies involving unplanned airborne releases of radioactive material from the facility. These meteorological capabilities will include upgrading of meteorological programs at nuclear facility sites, development of assessment capabilities, and meteorological data and analysis transmission capabilities in real-time. Regulatory guides are under development for nuclear facility design with respect to extreme meteorological events such as tornadoes, severe dust storms, lightning, extreme winds and temperatures, and snowloads.

APPENDIX C

ACRONYMS AND ABBREVIATIONS

ABDIS	Automated Service B Data Interchange System
ACPL	Atmospheric Cloud Physics Laboratory
ADWS	Automated Digital Weather Switch
AEPS	Automated Environmental Prediction System
AEW	Airborne Early Warning
AF	Air Force (USAF)
AFB	Air Force Base
AFCC	Air Force Communications Command
AFGWC	Air Force Global Weather Central
AFOS	Automation of Field Operations and Services
AFR	Air Force Regulations
AFRES	Air Force Reserve
AHOS	Automated Hydrologic Observing System
AIDJEX	Artic Ice Dynamics Joint Experiment
ALWOS	Automated Low Cost Weather Observation System
AMR	Aircraft Microwave Refractometer Automatic Meteorological System
AN/AMQ-29	Dropsonde Recording System (USAF)
AN/GMD-1	Military Upper Air Sounding System
AN/GMQ-10	Transmissometer (USAF)
AN/GUS-5	Laser Range Finder
AN/TMQ-31	Automatic Atmospheric Sounding Set
AN/TPS-68	Tactical Weather Radar (U.S. Air Force and Army)
AOIPS	Atmospheric and Oceanographic Information Processing System
APCL	Atmospheric Physics and Chemistry Laboratory
APT	Automatic Picture Transmission
AR	Army Regulations
ARGOS	French Data Collection System
ARQ	Automatic Response to Query
ARRS	Aerospace Rescue and Recovery Service
ARTCC	Air Route Traffic Control Center
ASL	Army Atmospheric Science Laboratory
ASW	Anti-Submarine Warfare
ATC	Air Traffic Control
AV-AWOS	Aviation Automated Observing System
AVHRR	Advanced Very High Resolution Radiometer
AWDS	Automated Weather Distribution System
AWES	Automated Weather System
AWOS	Automated Weather Observing System
AWN	Automated Weather Network
AWP	Aviation Weather Processor
AWR	Advanced Weather Radar
AWS	Air Weather Service

CAC	Climate Analysis Center
CAT	Clear Air Turbulence
CDA	Command and Data Acquisition
CDAS	Command and Data Acquisition Station
CDDF	Central Data Distribution Facility
CDMP	Cumulus Dynamics and Microphysics Program
CEAS	Center for Environmental Assessment Services
CO_2	Carbon Dioxide
COMEDS	Continental U.S. Meteorological Data System
COMNAVOCEANCOM	Commander Naval Oceanography Command
CONUS	Continental United States
COPPERHEAD	Artillery Projectile
CPU	Centralized Production Unit
CWSU	Center Weather Service Unit
DACS	Data Acquisition and Control Subsystem
DCPLS	Data Collection and Platform Location System
DCS	Data Collection System
DMSP	Defense Meteorological Satellite Program
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
DOT	Department of Transportation
DPSS	Data Processing and Services Subsystem
EBS	Emergency Broadcast System
EDF	Exploratory Development Facility
EDIS	Environmental Data and Information Service
E/O	Electro-Optical
EOSAEL	Electro-Optical Systems Admospheric Effects Library
EPA	Environmental Protection Agency
ERBSS	Earth Radiation Budget Satellite System
ERL	Environmental Research Laboratories
ESA	European Space Agency
ESM	Electronic Warfare Support Measures
ESSC	Environmental Studies Service Center
FAA	Federal Aviation Administration
FACE	Florida Area Cumulus Experiment
FAMAS	Field Artillery Meteorological Acquisition System
FCMSSR	Federal Committee for Meteorological Services and Supporting Research
FEMA	Federal Emergency Management Agency
FLENUMOCEAN	The Fleet Numerical Oceanography Center
FM-CW	Frequency Modulated - Continuous Wave
FNOC	Fleet Numerical Oceanography Center
FSS	Flight Service Station
FY	Fiscal Year
GAO	General Accounting Office
GARP	Global Atmospheric Research Program

GMT	Greenwich Mean Time
GMS	Japanese Synchronous Satellite
GOES	Geostationary Operational Environmental Satellite
GP	Genesis Potential
HEL	High Energy Laser
HIRS/2	Modified High Resolution Infrared Sounder
HRPT	High Resolution Picture Transmission
HRWS	Helicopter Remote Wind Sensor
ICAPS	Integrated Command Acoustic Prediction System
ICDI	Interim Climate Data Inventory
ICMSSR	Interdepartmental Committee for Meteorological Services and Supporting Research
IDB	Integrated Data Base
IPADS	Interactive Processing and Display System
IR	Infrared
ITOS	Improved TIROS Operational Satellite
JDOP	Joint Doppler Operational Project
JSPO	Joint System Program Office
KM (or km)	Kilometer
M	Million
MAC	Military Airlift Command
MARK IV	Mobile Direct Readout Terminal (U.S. Air Force)
MAVERICK	U.S. Air Force Missile System
MGA	Meteorological and Geoastrophysical Abstracts
MMS	Meteorological Measuring System
MOS	Model Output Statistics
MSU	Microwave Sounding Unit
NAFEC	National Aviation Facilities Experiment Center (FAA)
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NAVEASTOCEANCEN	Naval Eastern Oceanography Center, Norfolk, VA
NAVOCEANCOMCEN	Naval Oceanography Command Center
NAVOCEANCOMDET	Naval Oceanography Command Detachment
NAVOCEANCOMFAC	Naval Oceanography Command Facility
NAVOCEANO	Naval Oceanographic Office
NAVPOLAROCEANCEN	Naval Polar Oceanography Center, Suitland, MD
NAVWESTOCEANCEN	Naval Western Oceanography Center, Pearl Harbor, HI
NAWAS	National Warning System
NCC	National Climatic Center
NCPO	National Climate Program Office
NDBO	NOAA Data Buoy Office
NDC	National Distribution Circuit
NEDN	Naval Environmental Data Network
NEDS	Naval Environmental Display Station
NESS	National Earth Satellite Service
NEXRAD	Next Generation Radar Equipment
NHC	National Hurricane Center

NHEML	National Hurricane and Experimental Meteorology Laboratory
NHELTR	National High Energy Laser Test Range
NMC	National Meteorological Center
NMMW	Near Millimeter Wave Program
NOAA	National Oceanic and Atmospheric Administration
NOMSS	Naval Oceanographic and Meteorological Support System
NOS	National Ocean Survey
NOTAM	Military Notice to Airmen
NSF	National Science Foundation
NSSFC	National Severe Storms Forecast Center
NSSL	National Severe Storms Laboratory
NVEOL	Night Vision and Electro-Optics Laboratory
NWR	NOAA Weather Radio
NWS	National Weather Service
OL-192	Meteorological Data Processing Group (Personnel)
OLS	Operational Linescan Systems
OMB	Office of Management and Budget
OPARS	Optimum Path Aircraft Routing System
P-3	Four Engine Transport (Lockheed Orion)
PATWAS	Pilot Automatic Weather Answering Service
PDP	Program Development Plan
PROFS	Prototype Regional Observing and Forecasting System
PTD	Preparation, Transmission and Display System
RCA	Radio Corporation of America
R&D	Research and Development
RD/T&E	Research & Development, Test/Evaluation
RFC	River Forecast Center
ROMS	Remote Ocean Surface Measuring System
RVR	Runway Visual Range
SAEL	Sensor Atmospheric Effects Library
SATCOM	Satellite Communications System
SBUV	Solar Backscatter Ultraviolet Instrument
SCM	System Control and Monitor
SDHS	Satellite Data Handling System
SEA	Science and Education Administration (Agriculture)
SEAS	Shipboard Data Acquisition System
SEASAT	NASA's Research Satellite Dedicated to Marine Observations
SEL	Space Environment Laboratory
SEM	Space Environment Monitor
SESAME	Severe Environmental Storms and Mesoscale Experiment
SFSS	Satellite Field Services Station
SM-1	Army Tank
SMS	Synchronous Meteorological Satellite
SOCC	Satellite Operations Control Center
SPC	U.S. Navy Satellite Data Processing Center
SST	Supersonic Transport
SSU	Stratospheric Sounding Unit

TACMET	Tactical Weather Equipment
TESS	Tactical Environmental Support System
TFU	Tactical Forecast Unit
TIROS	Television Infrared Observation Satellite
TMQ-22	Tactical Observing Kit (U.S. Air Force and Army)
TOVS	TIROS N Operational Vertical Sounder
TRADOC	Army Training and Doctrine Command
TWS	Tactical Weather Systems
UNIVAC	Computer System
USAF	United States Air Force
USAFETAC	USAF Environmental Technical Applications Center
USC	United States Code
USCG	United States Coast Guard
USDA	U.S. Department of Agriculture
USN	United States Navy
UV	Ultraviolet
VAP	Voluntary Assistance Program
VAS	VISSR Atmospheric Sounder (GOES D and subsequent spacecraft)
VHRR	Very High Resolution Radiometer
VISSR	Visible and Infrared Spin Scan Radiometer
VOR	Very High Frequency Omni Range
VRS	Voice Response System
VTPR	Vertical Temperature Profile Radiometer
WEFAX	Weather Facsimile
WETM	Weather Team
WFSC	Weather Facsimile Switching Center
WMO	World Meteorological Organization
WMSC	Weather Message Switching Center
WSCMO	Weather Service Contract Meteorological Office
WSFO	Weather Service Forecast Office
WSMO	Weather Service Meteorological Office
WSMR	White Sands Missile Range
WSO	Weather Service Office
WWB	World Weather Building

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FEDERAL COMMITTEE FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH (FCMSSR)

FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

INTERDEPARTMENTAL COMMITTEE FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH (ICMSSR)

SUBCOMMITTEES

AVIATION SERVICES

SPACE ENVIRONMENT FORECASTING

SYSTEMS DEVELOPMENT

Working Groups

- o Automated Surface Observations
- o Automated Weather Information Systems
- o Radiological, Gaseous and Particulate Transport Models
- o Weather Radar Systems

OPERATIONAL ENVIRONMENTAL SATELLITES

BASIC SERVICES

Working Groups

- o Agricultural Meteorological Services
- o Cooperative Backup Among Operational Processing Centers
- o Dissemination of NMC Products
- o Hurricane Operations
- o Marine Environmental Predictions
- o Meteorological Codes
- o Metric Implementation
- o Operational Processing Centers
- o Severe Local Storms Operations
- o Surface Observations
- o Upper Air Observations
- o Weather Radar Observations
- o Winter Storms Operations
- o World Weather Program